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ROENTGEN TECHNIC

ROENTGEN TECHNIC

ROENTGEN TECHNIC

(DIAGNOSTIC)

BY

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AND FORD HOSPITAL, OMAHA, NEBR.

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PREFACE

This small volume has been prepared particularly for those general practitioners who have seen fit to install x-ray equipments along with the numerous other apparatus necessary in helping them to best care for those who come under their observation. There has been very little written in English, dealing exclusively with roentgen technic and it has seemed to the author, after having talked with many physicians, that such a publication is sorely needed.

It is so common to have one's attention drawn to a case where a physician is doing so-called gastrointestinal diagnosis by means of the roentgen ray, his entire proceeding consisting of an opaque meal followed by one plate taken with the clothing on, that one is led to believe that such a procedure is not due to negligence on the part of the physician, nor used for show only, but that it is due wholly and entirely to ignorance—the physician knowing nothing else to do. One also is brought face to face every day with the man who is taking bone plates one way only, and thereby at no time rendering a diagnosis of any value. But why should one wonder at these gross errors when one takes into consideration the preparation given the neophyte by the x-ray salesman? His machine is set up, a few plates hurriedly exposed and developed, all of which looks easy, and then he is left to his own resources. The consequence is, from the beginning he is working in the dark, never knowing the *why* and the *wherefore* of any process.

It is needless to say, from the fact that this book deals exclusively with roentgen technic from a diagnostic standpoint, that nothing has been said regarding interpretation. So much has been and is being written upon this branch of the subject by the masters that it is not for me to touch upon. It has been assumed that all readers of this volume are using interrupterless transformers; the coil, therefore, has not been given any consideration, as it has been abandoned almost universally for the former type of apparatus.

The author wishes to express his gratitude to his colleagues, Doctors Tyler and Kuegle, for information and suggestions tendered.

N. C. P.

CONTENTS

PAGE

CHAPTER I.

GENERAL PRINCIPLES 17

CHAPTER II.

X-RAY TUBES 24

CHAPTER III.

OPERATION OF MACHINE 27

CHAPTER IV.

GENERAL EXAMINATION ROUTINE 31

CHAPTER V.

POSITIONS AND EXPOSURES 39

CHAPTER VI.

SINUS INJECTION 103

CHAPTER VII.

LOCATION OF FOREIGN BODIES 104

CHAPTER VIII.

DARK ROOM PROCEDURES 107

ILLUSTRATIONS

FIG. PAGE

1. Pathway of current from line to tube 22
2. Old style gas tube 24
3. Coolidge tube 25
4. Gas tube connected to transformer 29
5. The advantage of taking a fracture in both planes 32
6. *A*. When tube is centered exactly over fracture. *B*. When tilted to one side 33
7. Plate changing tunnels for stereoscopy 34
8. Tilting side of Kelly tube stand 35
9. Shifting side of Kelly tube stand 35
10. Change in position of tube when taking stereoscopic plates . . . 36
11. Set of Hickey cones and diaphragms 37
12. Lead markers on adhesive strips 38
13. Anteroposterior wrist and hand position 41
14. Lateral wrist position 41
15. Anteroposterior elbow position 43
16. Lateral elbow position 43
17. Anteroposterior ankle position 45
18. Lateral ankle and lateral tarsus positions 45
19. Lateral ankle and lateral tarsus positions 47
20. Anteroposterior tarsus position 47
21. Anteroposterior knee position 49
22. Lateral knee position 49
23. Anteroposterior hip position 51
24. Anteroposterior pelvis position 53
25. Anteroposterior shoulder position 55
26. Lateral cervical spine position 57
27. Anteroposterior cervical spine position 57
28. Anteroposterior dorsal spine position 59
29. Oblique dorsal spine position 59
30. Anteroposterior lumbar spine position 61
31. Oblique lumbar spine position 61
32. Clavicle position 63
33. Scapula position 65
34. Kidney position 69
35. Bladder position on dorsum 69
36. Kidney position 72
37. Bladder position on dorsum 73
38. Prone bladder position 73
39. Chest position 77

FIG. PAGE
40. Lateral head position 79
41. Inferosuperior head position 79
42. Anteroposterior head position 80
43. Mastoid position 81
44. Mandible position 83
45. Position in taking upper teeth 85
46. Position in taking lower teeth 85
47. Gall bladder position 87
48. Position for esophagus 89
49. Prone stomach position 92
50. Oblique stomach position 93
51. Standing stomach position 93
52. Showing serial plate apparatus ready for use 95
53. Showing serial plate apparatus tilted upward when not in use . 96
54. Diagram showing relative distance between object and plate . . 105
55. Plate, cassette and envelope rack shelf in dark room 108
56. Ventilating shafts in dark room walls 109
57. A print drying on a ferrotype after squeegeeing 120
58. Showing camera mounted on permanent stand for lantern slide making 122
59. Rear of camera showing centering squares on ground glass . . 123
60. Simple method of arrangement for making lantern slides from illustrations 124
61. A negative 125
62. A positive 126
63. Manner in which envelopes are marked for filing 129
64. Case record book 130
65. Cross index card 132
66. Floor plan No. 1 135
67. Floor plan No. 2 135
68 Floor plan No. 3 135
69. Floor plan No. 4 136
70. Floor plan No. 5 136
71. Floor plan No. 6 137

ROENTGEN TECHNIC

(Diagnostic)

ROENTGEN TECHNIC

CHAPTER I

GENERAL PRINCIPLES

X-rays are certain rays of unknown number which are produced when a high tension current is forced through a specially constructed vacuum tube. These rays when produced will theoretically penetrate all substances, some with greater ease than others. The general rule is that the greater the atomic weight, the less the ease of penetration. The following list of common substances is given in order of their ease of penetrability:

1. Air.
2. Celluloid.
3. Aluminum.
4. Cardboard.
5. Wood.
6. Flesh.
7. Rubber.
8. Barium or bismuth.
9. Bone—teeth.
10. Steel.
11. Lead.

When centering x-rays on an object, these varying degrees of penetration take place; but in order to profit by them, there must be some way whereby they may be perceived. Two methods have been devised; namely, the fluorescent screen and the sensitized plate.

The Fluorescent Screen

The fluorescent screen is nothing more than an ordinary piece of cardboard coated with a combination of chemicals which have the peculiar property of fluorescing when exposed to the x-rays, the same as a match will fluoresce in the dark when rubbed between moist fingers. Of course, this fluorescence can not be seen except in darkness, and then only when the pupils of the eyes have dilated to their fullest, which will take from ten to twenty minutes. When the rays are generated, this screen will glow; and when the excitation of the tube has ceased, it will stop. Some makes of screens have what is known as a lag, that is, fluorescence continues for some few seconds after the discontinuance of the energy in the tube. Unless the operator is shifting from one area to another very rapidly, this will have no detrimental effect. There are also two distinct colors in an illuminated screen, one having a greenish cast, the other black and white. One is probably as good as the other, the preference depending largely upon the operator.

If the tube is excited, thereby causing the screen to fluoresce, and some object is interposed between the tube and the screen, naturally the x-rays do not reach the screen in as unhindered a state as they do when no object interferes; therefore, as x-rays to all practical purposes only travel in straight lines, the portion of the screen that is covered by the interfering object will not fluoresce to as great a degree as the areas not so covered, and one is thereby enabled to discern the shape of the object. The fluorescence will be hindered directly according to the difficulty of the rays in passing through the object. As an example, if a number of objects, say a hand with a bullet supported upon the palm, is interposed between an excited tube and a screen, the image will show the bullet practically black, as no rays are penetrating it; and therefore the screen is not fluorescing at this point. Next, the bones are seen as a sort of a grayish black because some little amount of the rays is coming through and causing a slight fluorescence. Next, the flesh is seen surrounding the bones. This is a very light gray color because a large part of the rays is coming through the flesh and causing the screen to light up; and lastly, the air surrounding the hand is no hindrance to the rays, and the entire action is thrown on the screen which is fully illuminated.

The Sensitized Plate

The sensitized plate or film is briefly a piece of clear glass or celluloid coated with certain chemicals in a gelatine solution which has been allowed to dry (dry plate). The coating, film, or emulsion, as it is called, is prepared from a number of substances, the main one being some salt of silver which is mixed with liquid gelatine; and after having gone through a process of heating and washing, this substance is ready to be spread very thinly and evenly on the supporting medium and set away to dry. During the latter part of the process of preparation, the emulsion takes on a property whereby if it is exposed to the rays of the solar spectrum, except red, and then put into a solution of certain reducing chemicals, the silver will turn black; whereas if it is not so exposed and put into the solution, it will remain its original color, a very light creamy yellow. All the rays of the spectrum act on the silver except red, the ultra-violet probably exerting the greater part of the change.

The x-rays possess this same power, and, therefore, when an unexposed plate is placed near an excited x-ray tube and then put into the developing solution, it will be found to have undergone the change and will turn black instead of remaining its original creamy color. Now, if some object, say a bullet, is interposed between the plate and the tube, it is easy to see that the part of the plate covered, as it were, by the bullet will not receive as much, if any, of the rays as the parts not so covered. The surface so covered by the bullet will remain creamy, while the surrounding parts that get the full effect of the rays will turn black. In this way it is possible to distinguish that a bullet was on the plate at the time of exposure. Therefore, if the same illustration is taken as was used for the fluorescent screen, the same end is accomplished, except the colors are reversed. On the screen it was seen that the bullet remained black because the x-rays could not get through to fluoresce the screen, but on the plate it is seen that the bullet remains creamy for the same reason, the rays can not get through to allow the silver to be acted upon and it therefore remains its original color.

An intensifying screen is a piece of cardboard coated over with certain chemicals somewhat the same as a fluorescent screen. The chemicals used, however, are different so that one can not be used satisfactorily in the other's stead as has been tried and demonstrated. This screen is very sensitive to x-rays, and for this reason is used in connection with plate work to shorten the time of exposure. The coated side of the screen is placed in contact with the film side of the plate, either in a specially constructed holder for this purpose called a cassette, or in the ordinary loading envelope. The latter method is rarely used, as the surface of the screen is very easily marred, and if scratched or splattered with chemicals, is forever useless, these defects showing on all plates subsequently taken with it.

If the minutest quantity of rays strikes the screen, it will act by lighting up. This, in turn, affects the plate at this point and the image is made. Without an intensifying screen, one has to have enough rays to properly affect the silver in the plate to make the desired impression. Intensifying screens seem to respond particularly well to soft rays, therefore, in using these screens, a medium soft tube should be employed. The great difficulty in their use is in overexposing the plates. The latitude of error is very narrow; the plate must be exposed just right or a poor negative will result, whereas, with the plain plate, a slight over- or underexposure will not be noticeable.

For producing the rays to reproduce some object on a sensitized plate, there are three main things one has to take into consideration; namely, amount of voltage used, number of milliamperes of current, and the distance from the anode of the tube to the plate. For all practical purposes the voltage varies from 55,000 to 70,000 and the milliamperage from 35 to 140. It is roughly estimated that 10,000 volts will span a gap (air space) of one inch, therefore, if there is a gap of 5½ inches which the current will span, but no farther, it can be assumed that the current is approximately 55,000 volts, and with a 7 inch gap, 70,000 volts.

In the positive side of the circuit there is usually set what is known as a milliammeter, a gauge for registering the number of milliamperes (one-thousandth part of an ampere) passing through the tube. This milliampere reading depends, if a gas tube is used, upon the degree of vacuum in the tube, but if a Coolidge tube is employed, a different principle is involved, this device depending on the degree of heat in a small tungsten filament which is placed in the circuit within the tube. In the gas bulb, the greater the vacuum the lower the milliamperage, and the harder the tube. In the Coolidge tube, the greater the heat in the filament the more electrons are set free and this in turn allows more milliamperes to pass, and we therefore have a softer tube. In Fig. 1 a schematic sketch has been made of the current so as to make the course in the production of x-rays more easily understood.

The electrical current is seen to travel in a circle, the

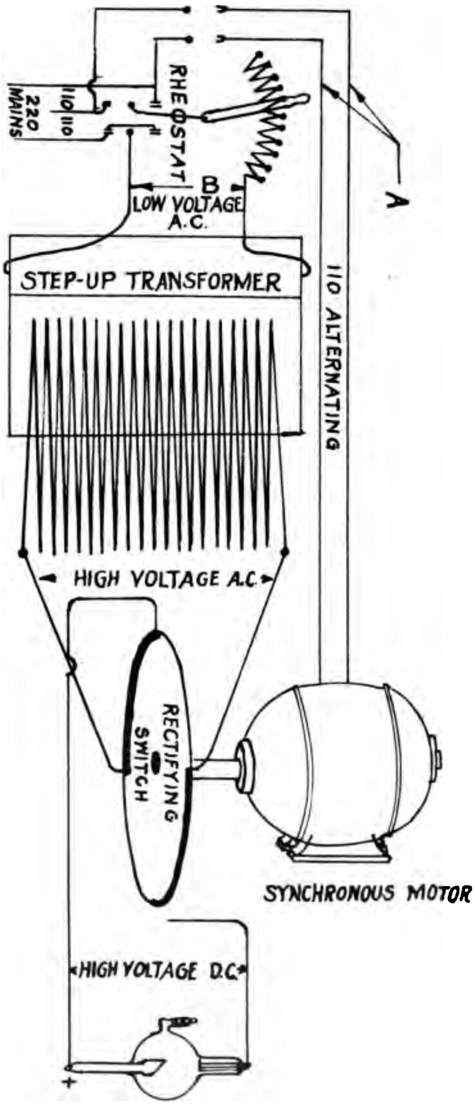

Fig. 1.—Pathway of current from line to tube.

outgoing wire being the positive (+) and the incoming, the negative (—). It accomplishes its work while traveling the circle, the whole thing being known as the circuit.

From the source of supply, the current (alternating assumed) is taken two ways; namely, (a) to the motor and (b) to the tube via the transformer. The current that goes to the motor does not enter into the production of the x-rays, but is simply for excitation of the motor which in turn causes the rectifying wheel or switch to revolve. The supply or incoming current is small, usually 220 volts. When this emerges from the coil or transformer, it has been raised in voltage, or ''stepped up'' as it is termed, so that it is now a high tension current, whereas before this raising process it was of low tension. As it flows through the rapidly revolving rectifying wheel it is changed into a direct current which is necessary for the successful operation of an x-ray tube. If the current is not prevented, it will flow through the tube and back to the source, thus completing the circuit. At points C and D (Fig. 4) there are rods so arranged that their ends can be placed at varying distances from each other. If these points are brought very close together, the current will take this, the easiest route, not going around by the way of the tube. This is what is known as the spark gap.

CHAPTER II

X-RAY TUBES

X-ray tubes are of two general classes; namely, gas tubes and Coolidge tubes, and operate upon two distinct principles.

The gas tube (Fig. 2) is a glass bulb with the air exhausted to a certain point, nearly a complete vacuum.

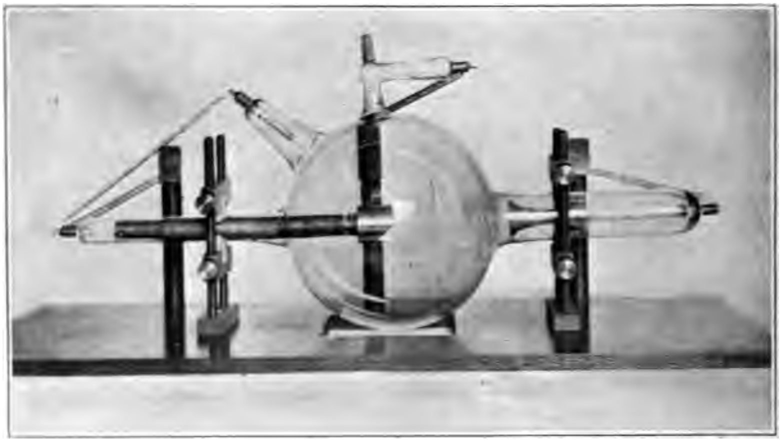

Fig. 2.—Old style gas tube.

It is equipped with a regulating chamber so that a small quantity of air can be let in which will, of course, reduce the vacuum. With such a tube the current which travels through it of necessity must pass through this partial vacuum. It has been determined that the nearer a perfect vacuum in a tube, the harder it is to force an electrical current through it, but when forced through a high vacuum, hard rays are given forth, and they are more penetrating and less likely to burn than the soft ones.

Conversely the less perfect the vacuum or the more air in the tube, the easier to force the current through, and soft rays are produced. It is easy to see that if the vacuum or resistance in the tube is greater than the spark gap resistance, the current will take the easier route and jump the gap. If the gap is now increased to such a point that the current will pass through the tube in preference to the gap, the tube is said to be backing up a parallel spark gap of so many inches. If, however, it is desired that the tube back up so many inches and no more, just enough air should be admitted so that it will not jump that distance. The tube is then as desired.

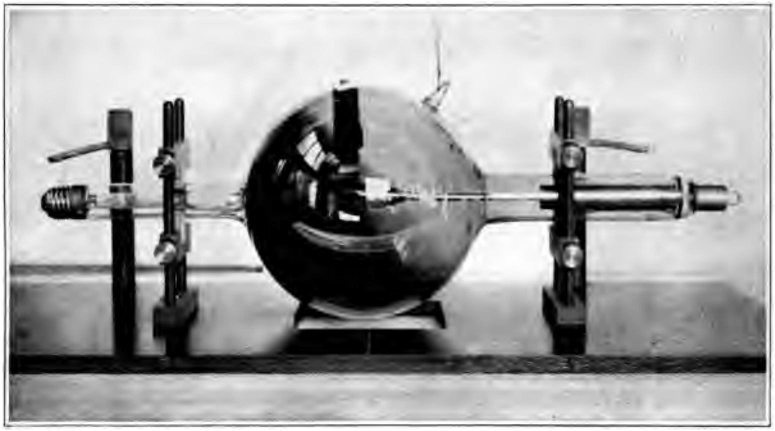

Fig. 3.—Coolidge tube.

The Coolidge tube (Fig. 3) is operated upon an entirely different principle. It is pumped to an almost perfect vacuum which remains the same constantly. At the negative end of the tube is a small tungsten filament within the pumped bulb. This is lighted by means of an attachment to an ordinary light socket. It, however, will take only approximately 12 volts so that the current which usually is of 110 volts capacity must be cut down to the required 12 volts. This is accomplished by a small apparatus known as a step-down transformer. The intensity of this light can be increased or diminished at the will of the operator by means of a little instrument known as the filament control. When the filament is burning its maximum of current or is at its brightest, the tube will take the most current, the same as would the gas tube when it had the maximum of air in it. In either instance the tube is spoken of as a soft tube. Conversely when the filament is burning low or as in the case of a gas tube, when the air is at its lowest, then the tube is hard.

The intensity of the x-rays is in inverse proportion to the square of the distance. If the exposure for a certain part is three seconds with ten inches between the plate and the anode, the time of exposure required for increased distances will be as follows:

Distance in inches	Time in seconds	Distance in inches	Time in seconds	Distance in inches	Time in seconds
10	3	17	8.67	24	17.28
11	3.63	18	9.72	25	18.75
12	4.32	19	10.83	26	20.28
13	5.07	20	12	27	21.87
14	5.88	21	13.23	28	23.52
15	6.75	22	14.52	29	25.23
16	7.68	23	15.87	30	27.

CHAPTER III

OPERATION OF MACHINE

After the installation of the equipment, the first thing for the beginner to do is to test out his tubes so that he may know what setting he wants when different parts come up for roentgenographing. First, after starting the motor (assuming he has an interrupterless transformer) and setting the polarity switch as indicated, he lights the filament in the Coolidge tube, if such is to be used, setting the control at a point about one-half way of the scale. The spark gap is set about 4½ inches, and the rheostat placed on about the 20th button or about two-thirds out. The final or x-ray switch is now closed and if the gap is not spanned by the current, the control is reduced or sent backwards a few points and the procedure repeated. If the spark jumps the gap the filament light is increased and so on until such a point is reached that the current is such that it will constantly spit across the gap, the milliamperage being noted. If it is in the neighborhood of 35, let it stand. If lower, increase the control button. This will require a change in the filament again. By manipulating the rheostat and the control button of the filament, one can finally get an output that will record a certain number of milliamperes with a certain backup spark. When once 35 milliamperes backing up 5½ inches has been found, note it on paper. Now set tube so that it will carry 75 milliamperes with a 6 inch gap as also the following:

90 ma. backing up a 6 inch gap.
40 " " " " 6½ " "
70 " " " " 6½ " "
100 " " " " 6½ " "
140 " " " " 6½ " "
60 " " " " 4½ " "

After these have all been set down on paper one will have something like the following:

MILLIAMPERES	COOLIDGE CONTROL	SPARK GAP	RHEOSTAT CONTROL BUTTON
60	4 13/20	4½	24
35	4 3/20	5½	22
75	4 12/20	6	25
90	4 8/20	6	26
60	4 3/20	6½	25
70	4 4/20	6½	26
100	4 6/20	6½	27
140	4 4/20	6½	28

The gap can now be opened to its fullest capacity, and unless some new combination is to be used, it need never be closed again, for with a given Coolidge tube, one will always get an exact duplication if the same formula is followed. If a gas tube is used, a different procedure is employed. The rheostat is set on the first button and the spark gap placed at say, 6 inches. The x-ray switch is now closed. The meter will probably read somewhere between 20 and 30 milliamperes. Now the rheostat can be thrown over several buttons until the spark gap is spanned. It is then reduced one button and the milliamperage noted. If this is too hard a tube, it can be lowered by sending a small amount of current through the regulating chamber. This is accomplished either by connecting the chamber to a cord connected to a movable reel placed on the front of the transformer, the reel being capable of being drawn close to the negative post; or by means of a stiff wire attached to the chamber, the end of which can be brought in close proximity to the negative end. (Fig. 4.) The current normally goes from A to B directly through the tube. If the tube is to be reduced or softened, cord F is connected to the regulating chamber at G, and E is brought close to D, which is done by tension on a string. The rheostat is put on the first button and the final switch is closed. This sends the current through the regulating chamber G back to D instead of through B. Sometimes a wire is used from G to B. The current then passes from A to B via G instead of A to B. When the wire is not in use, it is tilted upwards so that it will not get in the circuit. When gas tubes are to be used, several should be employed, each having a different backup gap as it is not only very annoying but soon ruins a gas tube to be continually changing its vacuum.

When using the fluoroscope, usually about 2 ma. are employed, the penetration being regulated by the filament when using the Coolidge or by the third wire with the gas tube. On all the latest fluoroscopes there is a little device whereby the operator can control the gas tube in the apparatus simply by pulling a string the same as on the transformer when regulating for picture work. This approximates the wire connected to the regulating chamber and the negative post, thereby reducing the tube. As soon as the tube is reduced sufficiently, the string is released and the two points fly apart. This

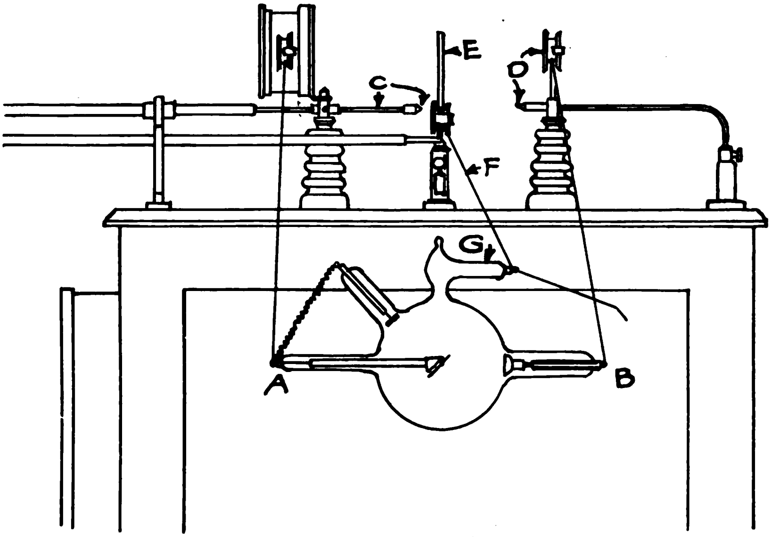

Fig. 4.—Gas tube connected to transformer.

can be done while the machine is in operation as the milliamperage is so low (2 ma.) that the reduction is more or less gradual. If this were done with a roentgenographic tube running with, say 40 ma., the reduction would be so rapid even in a fractional part of a second that the tube would be worthless from over reduction. It would be so soft that it would have no penetration.

CHAPTER IV

GENERAL EXAMINATION ROUTINE

When a patient is submitted for x-ray examination, first take a complete history. The following is a good general chart:

No. ______ Name ________________________
Address ______________________
Past history, __________________________________
Present sickness or accident, _________________________
Physical findings, _____________________________________
Clinical diagnosis, _____________________________________
Roentgenological diagnosis, __________________________
Date, __________ Charge, __________
Size plate, _______ Referred by, _______________
____

This is made a convenient size to file alphabetically. After the history is taken, the patient goes to the dressing room and bares the part to be examined. If a spinal, gastrointestinal, chest, or genitourinary examination is to be made, all the clothing is removed, and if a female, a white washable gown is slipped on. The patient is then placed on the table and a complete physical examination is made, all points being noted on the chart. The x-ray examination is then proceeded with.

In the taking of any roentgenogram, there are three things that must always be remembered; namely,

1. Have the tube centered as nearly over the lesion as possible.

2. Place the part to be taken as near the plate as is convenient.

3. Have the rays strike the plate at right angles unless the part can be shown to better advantage otherwise,

and the accompanying distortion does not make any material difference.

Taking these up in their order, (1) it will be seen in the accompanying illustration that it is possible to make, for instance, a fracture appear different from what it really is by not being particular in this regard (Fig. 6).

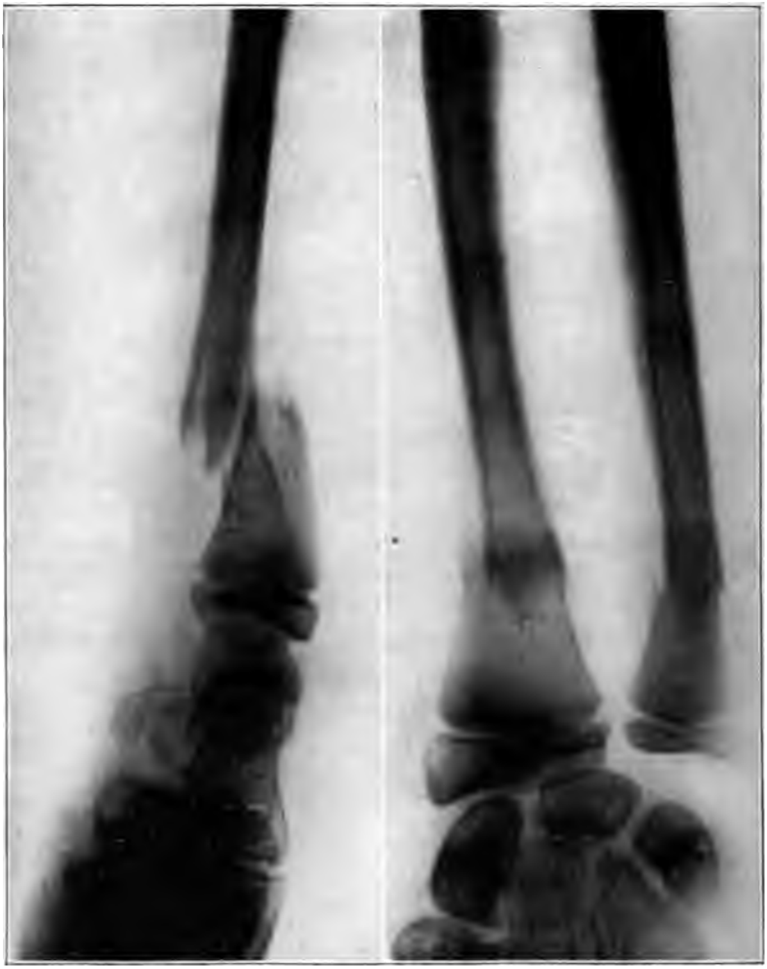

Fig. 5.—The advantage of taking a fracture in both planes.

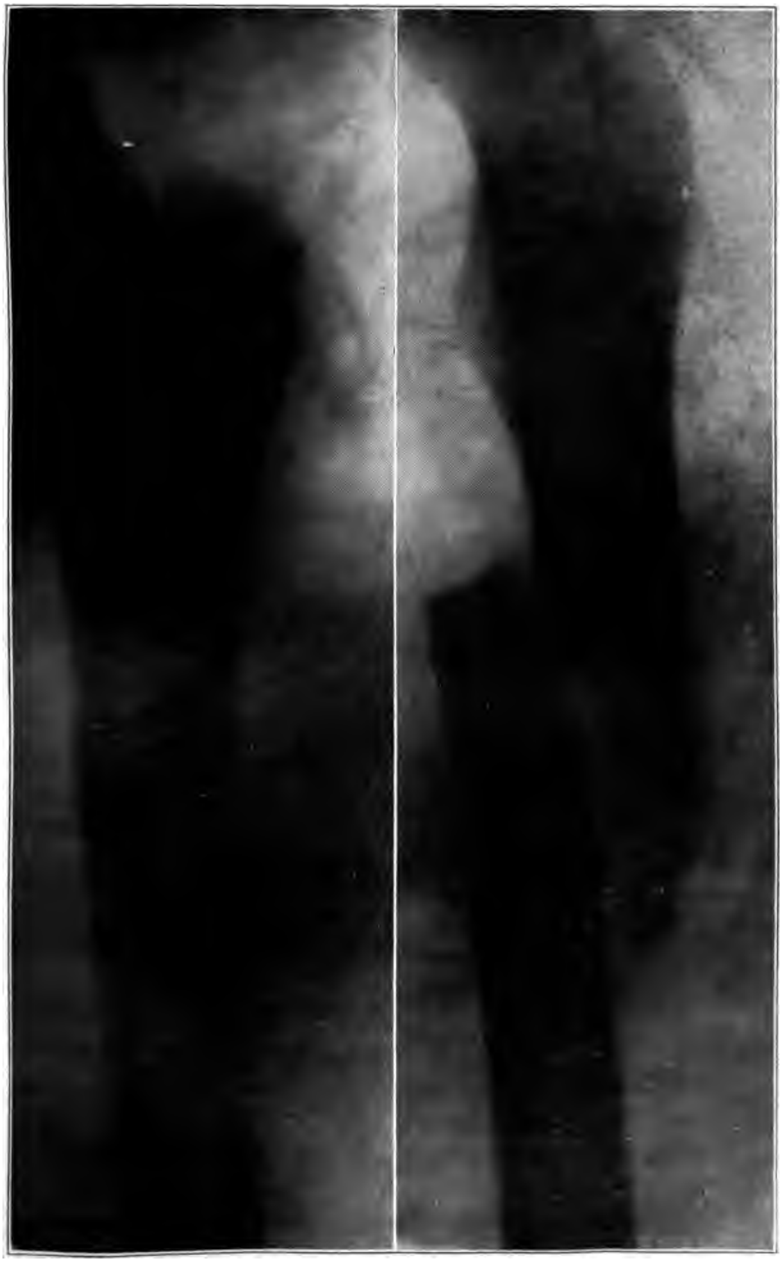

Fig. 6.—*A*. When tube is centered exactly over fracture. *B*. When tilted to one side.

(2) The nearer an object is to the plate the clearer it will appear and the nearer to its normal size, whereas, if removed to any considerable distance, it will appear hazy and very much magnified. (3) If the tube is not placed so that the rays strike the plate at right angles, overlying parts will be thrown out of their true relationship and other parts will be distorted as to their size and shape.

In all extremity work, views should be taken in two directions, that is, anteroposteriorly and laterally. If this is not done very faulty diagnoses may be made. A transverse fracture with the lower fragment lying posteriorly to the upper, will in a large majority of cases not show the misplacement if taken anteroposteriorly, but if a plate is taken laterally, the faulty position will be easily seen. (Fig. 5.) Two plates are not only more expensive but are not so convenient to handle as one, and therefore a single plate large enough to take in both views is used, the half not under exposure being covered by a sheet of 1/16 inch lead. A pencil mark should be made on the envelope where the lead stops so that one may know where to edge it when making the other exposure. If it is impossible to get a lateral view of a part as, for instance, the shoulder and hip, the stereoscopic method should be employed. This is accomplished by the use of two plates and by shifting the tube. A thin box, the proper size to hold the covered plate, is placed under the part (Fig. 7) and the patient instructed

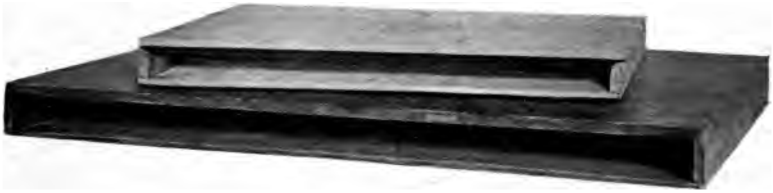
Fig. 7.—Plate changing tunnels for stereoscopy.

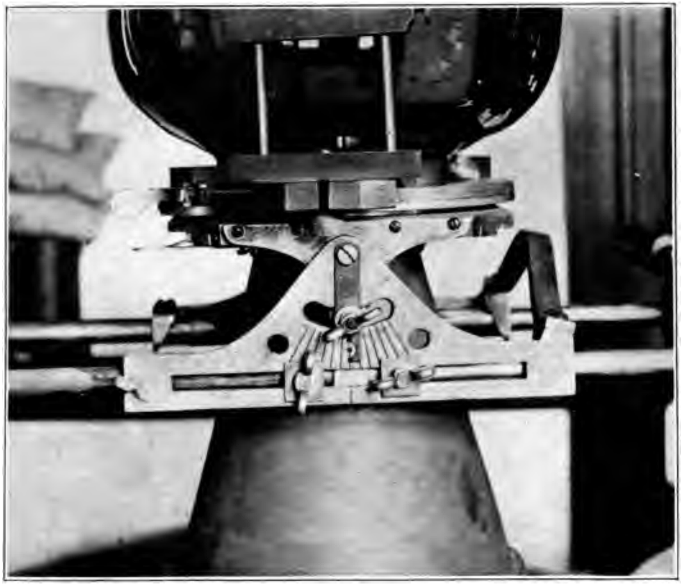

Fig. 8.—Tilting side of Kelly tube stand.

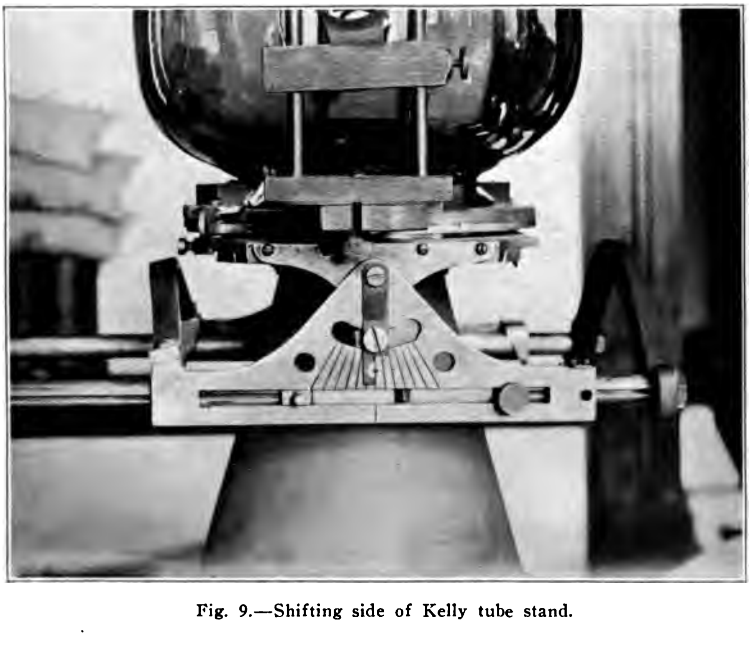

Fig. 9.—Shifting side of Kelly tube stand.

that two plates are about to be taken and not to move until the sign is given. The tube is centered exactly over the part to be taken and by a special device on all stands locked at this point, the tube is allowed to move

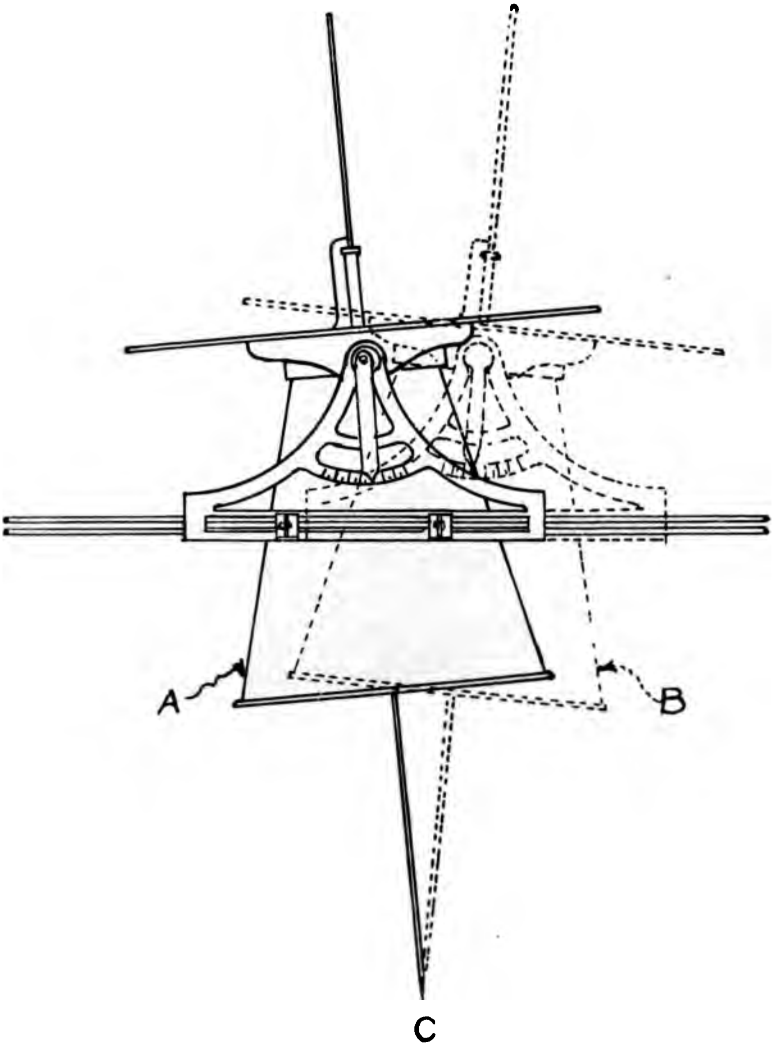

Fig. 10.—Change in position of tube when taking stereoscopic plates.

both ways one and one-quarter inches. This 2½ inches, as will be seen later, is the approximate distance between the two pupils of the eyes. It is also necessary to tilt the tube by a special tilting device so that the direct rays are at both extremes pointing to the center. (See Figs. 8 and 9.)

A plate is slipped into the box and tube placed in position A (Fig. 10) and the exposure made. This plate is then removed and placed in a safe place and another slipped into the box in the same relative position, all this time the patient should remain absolutely quiet. The tube is now shifted to position B and the exposure made, both plates having the same time. When taking the plates to the dark room, number them No. 1 and No. 2 in the order they were exposed. This will be found useful when placing them in the stereoscope. If No. 1 is placed on the left side and No. 2 on the right, the stereoscopic effect will be obtained almost at once. The changing boxes should be four in number. Two capable of holding 8 by 10 inch envelopes and two for the 11 by 14 inch size; one of each size having the opening on the

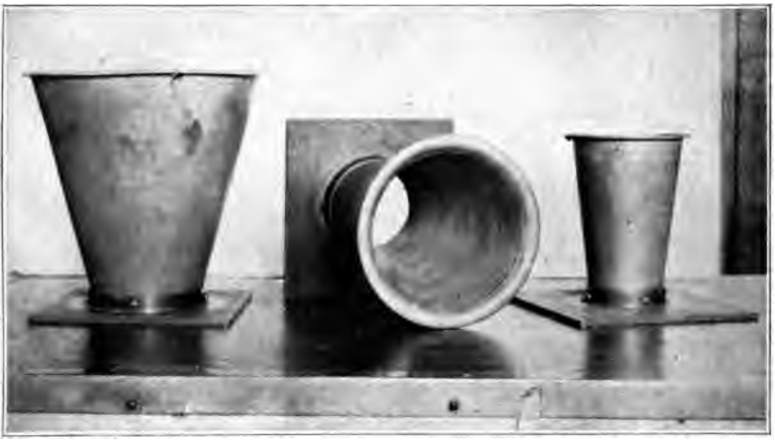

Fig. 11.—Set of Hickey cones and diaphragms.

end and the other on the side. They are made of wood, the top being of either celluloid, aluminum, cardboard, or thin wood, all of which offer little resistance to the rays. If wood is used, it should be free from knots and as thin as consistent with the weight that is put upon it. One small point that is well to remember with this stereoscopic work is that the black and orange envelopes in which the plates are enclosed are always somewhat larger than the plate. This is done, of course, to facilitate loading them. When placing the two plates in the box, they should be shaken into one corner or the other and placed in corresponding positions at each exposure. It makes no difference which corner just so they occupy the same in the box.

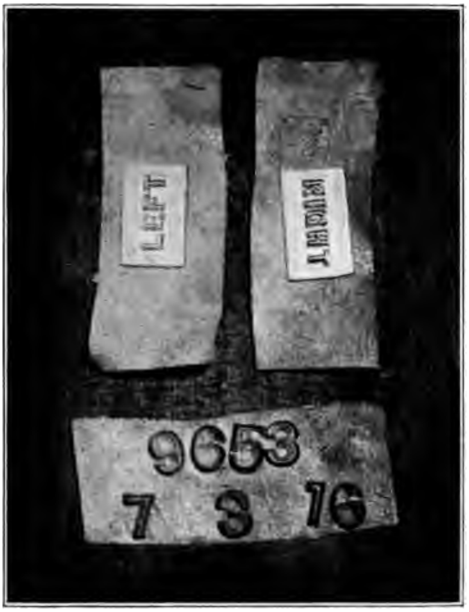

Fig. 12.—Lead markers on adhesive strips.

CHAPTER V

POSITIONS AND EXPOSURES

All of the following exposure times are given for regular Paragon or Seed plates and Cramer plates. If Cramer's are used with the technic calling for Paragon or Seed's, increase the time 25 per cent as the former are about that much slower. Detail in all will be about the same. If an intensifying screen is to be used, divide the time given about one-eighth. Intensifying screens do not act well with regular Paragon plates. If it is desired to use this make with screens, get the "screen" plate, which is made especially for this class of work. Cramer's and Seed's plates seem to work as well with or without, the time being shortened as above stated.

In the following list of exposure times, two technics are used in some instances. It might be well to try them both out, selecting that which seems to give the best plates. Some prefer the one while some like the other. With the first, it is noticed that Paragon or Seed's are used and with the second, Cramer's. All times are given on a basis of an adult about 5 feet 10 inches tall and weighing about 160 pounds. Give a little more or less according to weight. Recently a new plate has been placed upon the market (Diagnostic). This the author has found to be very fast, having four times the speed of the Cramer and twice that of the Paragon when used directly. With a screen its speed is not so marked.

Part.—Hand and Wrist

Size of Plate.	8x10, or 6½x8½.	
Diaphragm.	Large.	
Position.	Center over part desired.	
Name of Plate.	Paragon or Seed's.	Cramer's.
Number of Exposures.	Two. Anteroposterior and lateral.	Two. Anteroposterior and lateral.
Spark Gap.	5½ inches.	4½ inches.
Milliamperage.	35 ma.	60 ma.
Distance.	18 inches.	22 inches.
Time.	Anteroposterior ⅓ second, lateral ½ second.	Anteroposterior 1½ seconds, lateral 2 seconds.

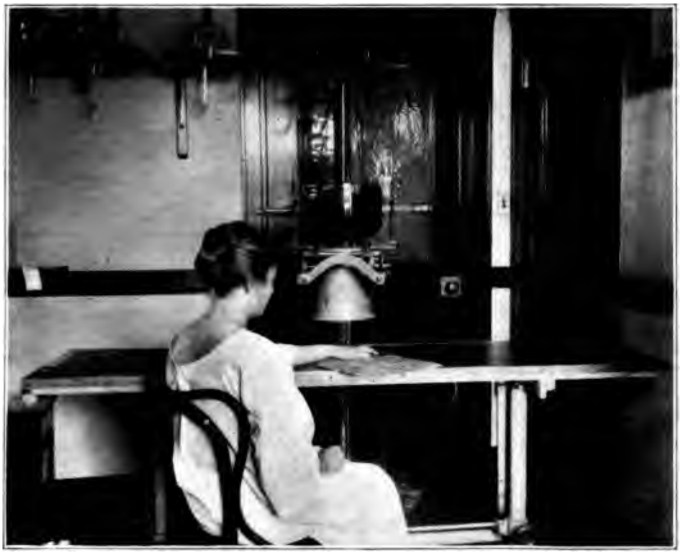

Fig. 13.—Anteroposterior wrist and hand position.

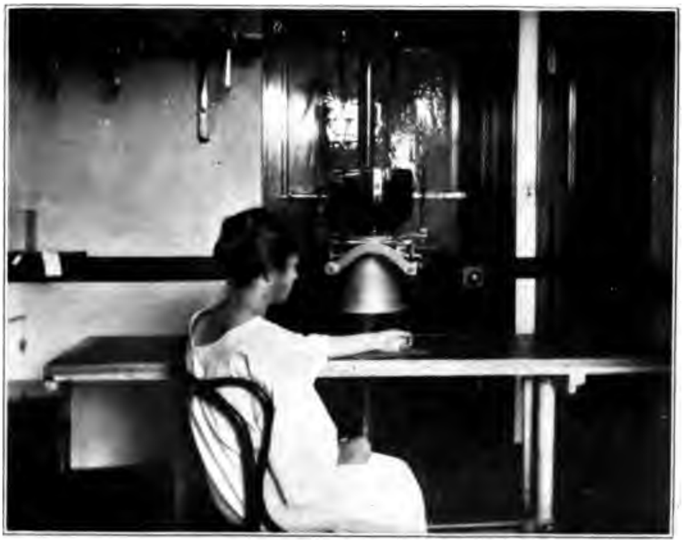

Fig. 14.—Lateral wrist position.

Part.—Elbow

Size of Plate.	8x10.	
Diaphragm.	Large.	
Position.	Center between condyles.	
Name of Plate.	Paragon or Seed's.	Cramer's.
Number of Exposures.	Two. Anteroposterior and lateral.	Anteroposterior and lateral.
Spark Gap.	5½ inches.	4½ inches.
Milliamperage.	35 ma.	60 ma.
Distance.	18 inches.	22 inches.
Time.	Anteroposterior, ¾ second; lateral, ½ second.	Anteroposterior, 3 seconds; lateral, 2½ seconds.

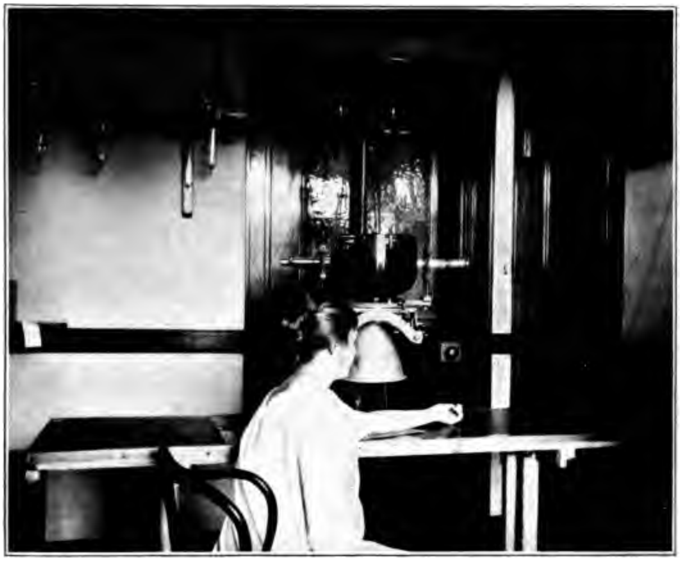

Fig. 15.—Anteroposterior elbow position.

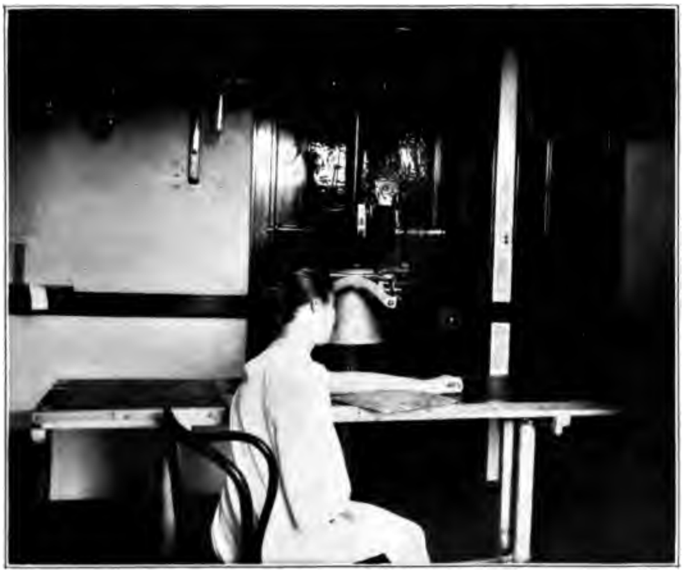

Fig. 16.—Lateral elbow position.

Part.—Ankle

Size of Plate.	8x10.	
Diaphragm.	Large.	
Position.	Through malleoli.	
Name of Plate.	Paragon or Seed's.	Cramer's.
Number of Exposures.	Two. Anteroposterior, and lateral.	Two. Anteroposterior, and lateral.
Spark Gap.	5½ inches.	4½ inches.
Milliamperage.	35 ma.	60 ma.
Distance.	18 inches.	22 inches.
Time.	Anteroposterior, 1½ seconds; lateral, 1 second.	Anteroposterior, 3 seconds; lateral, 2½ seconds.

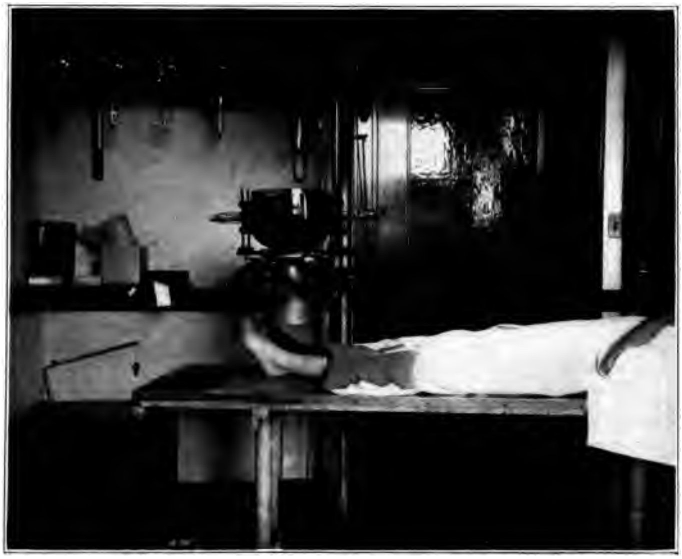

Fig. 17.—Anteroposterior ankle position.

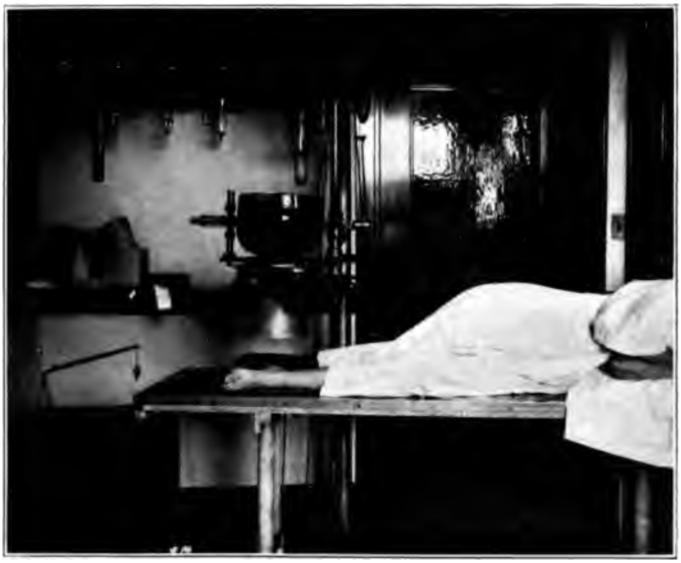

Fig. 18.—Lateral ankle and lateral tarsus positions.

Part.—Foot

Size of Plate. 8x10. (3)

Diaphragm. Large.

Position. First a stereoscopic set should be taken with the foot on its external side. This should take in all the foot and ankle joint. One plate (8x10) should now be taken anteroposteriorly, the patient lying on the back with the knee drawn up so that the plantar surface is resting firmly on the plate. The tube should now be brought down so that the principle rays are centered over the tarsus, tilting the tube so that the rays point a little toward the heel. In order to bring out the tarsus well in this position, the toes will have to be somewhat overexposed. If only the toes or metatarsal bones are desired, the exposure will necessarily be somewhat shorter. (Figs. 19 and 20.)

Name of Plate.	Paragon or Seed's.	Cramer's.
Number of Exposures.	Three.	Three.
Spark Gap.	5½ inches.	4½ inches.
Milliamperage.	35 ma.	60 ma.
Distance.	18 inches.	22 inches.
Time.	Anteroposterior, 1¾ seconds; lateral, 1 second.	Anteroposterior, 3 seconds; lateral, 2 seconds.

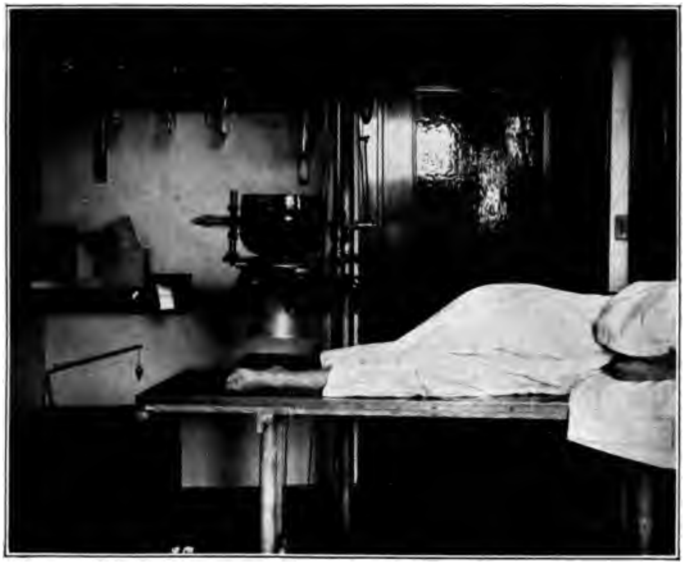

Fig. 19.—Lateral ankle and lateral tarsus positions.

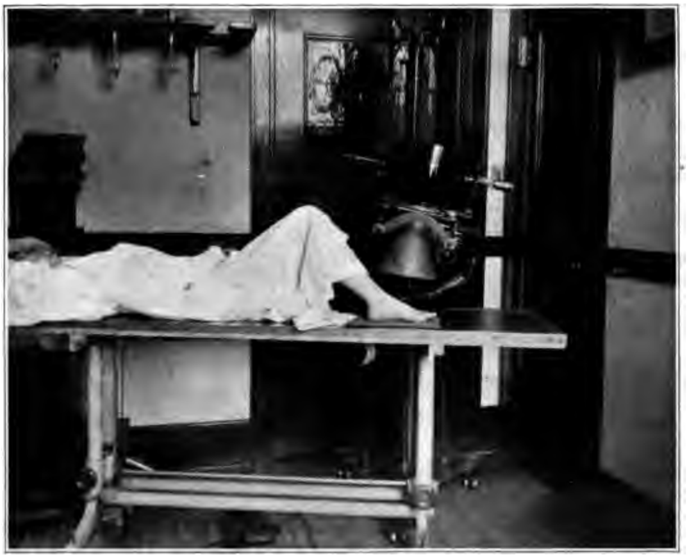

Fig. 20.—Anteroposterior tarsus position.

Part.—Knee

Size of Plate. 10x12.

Diaphragm. Large.

Position. Place patient on back, with the center of the plate at a point about 2 inches below the patella (Fig. 21); also one exposure with patient lying on affected side with plate centered over same point (Fig. 22).

Name of Plate.	Paragon or Seed's.	Cramer's
Number of Exposures.	Two.	Two.
Spark Gap.	5½ inches.	4½ inches.
Milliamperage.	35 ma.	60 ma.
Distance.	18 inches.	22 inches.
Time.	Anteroposterior, 1¾ seconds; lateral, 1½ seconds.	Anteroposterior, 3 seconds; lateral, 2½ seconds.

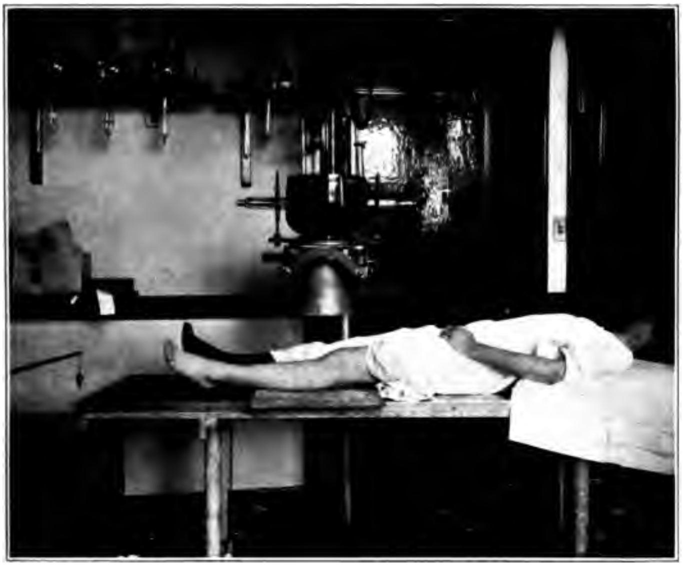

Fig. 21.—Anteroposterior knee position.

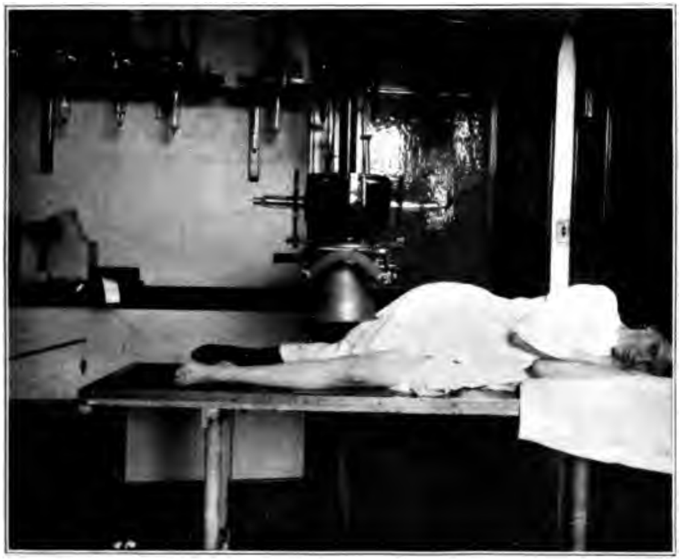

Fig. 22.—Lateral knee position.

Part.—Hip

Size of Plate. 8x10.

Diaphragm. Large with cone.

Position. Place tip of thumb over highest point of iliac crest, tip of middle finger over great trochanter and with the tip of the first finger form a triangle. At this point, center the principal rays. Bring the cone in contact with the skin without compression. (Fig. 23.)

Name of Plate.	Paragon or Seed's.	Cramer's.
Number of Exposures.	Two. Stereoscopical.	Two. Stereoscopical.
Spark Gap.	6 inches (without screen).	4½ inches (with screen).
Milliamperage.	90 ma. (without screen).	60 ma. (with screen).
Distance.	Contact, or as near 20 inches as possible.	Contact, or as near 20 inches as possible.
Time.	1 second (without screen).	3 seconds (with screen).

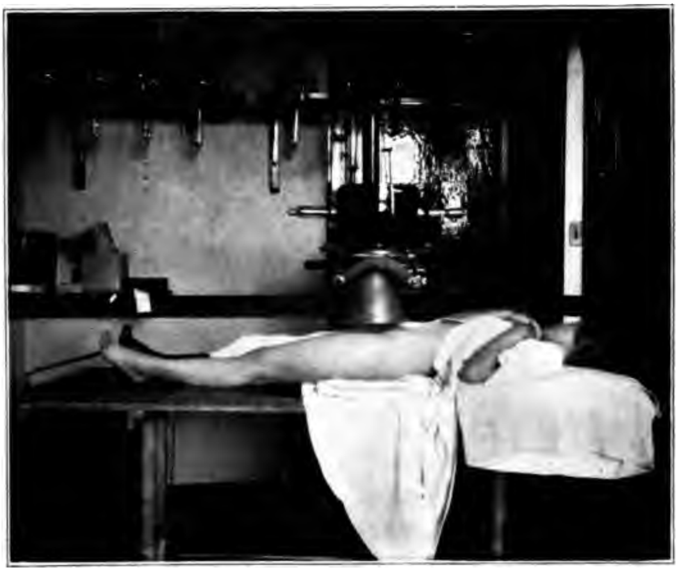

Fig. 23.—Anteroposterior hip position.

Part.—Pelvis

Size of Plate. 11x14.

Diaphragm. Large or none (see below).

Position. The patient is placed on the back with the plate extending crosswise at the point midway from the upper and lower edge site of the femoral head, as shown in Fig. 24. (To find the femoral head, place the tip of the thumb on the highest point of the iliac crest, the tip of the middle finger on the greater trochanter and with the tip of the index finger, form a triangle, the point over which the index finger rests is the approximate site of the femoral head.)

Name of Plate.	Paragon, or Seed's.	Cramer's.
Number of Exposures.	Two. Stereoscopical.	Two. Stereoscopical.
Spark Gap.	6 inches (without screen).	4½ inches (with screen).
Milliamperage.	90 ma. (without screen).	60 ma. (with screen).
Distance.	20 inches. (If a diaphragm is used, the distance will have to be increased to 27 inches.)	20 inches. (If a diaphragm is used, the distance will have to be increased to 27 inches.)
Time.	1 second at 20 inches without screen, or 1 8/10 seconds at 27 inches without screen.	3 seconds with screen at 20 inches, or 5½ seconds with screen at 27 inches.

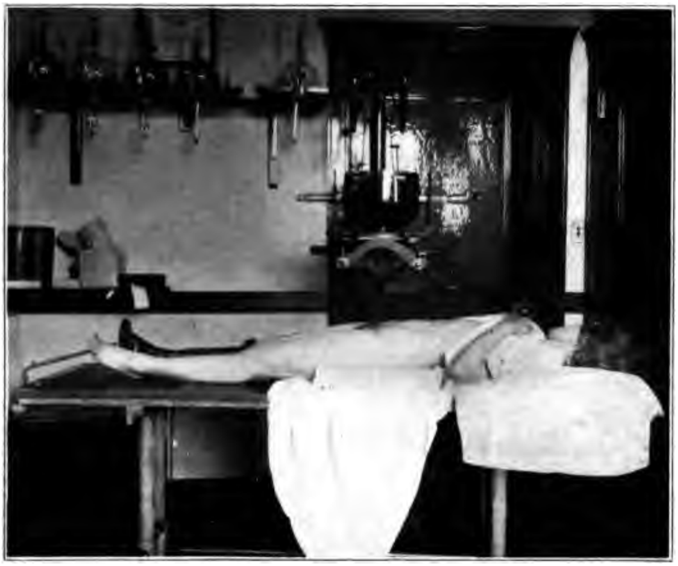

Fig. 24.—Anteroposterior pelvis position.

Part.— Shoulder

Size of Plate. 8x10. (Two stereoscopical.)

Diaphragm. Large.

Position. Center rays a little internal and slightly above axilla (Fig. 25). This examination should always be made stereoscopically, as it is impossible to get two way plates satisfactorily. The stereoscopic box or plate holder is placed under the affected shoulder and a book or other object about twice the thickness of the box is placed under the opposite side. This throws the shoulder to be taken well down on the holder, thereby insuring good detail.

Name of Plate.	Paragon or Seed's.	Cramer's.
Number of Exposures.	Two.	Two.
Spark Gap.	5½ inches.	4½ inches.
Milliamperage.	35 ma.	60 ma.
Distance.	18 inches.	22 inches.
Time.	2½ seconds.	4 seconds.

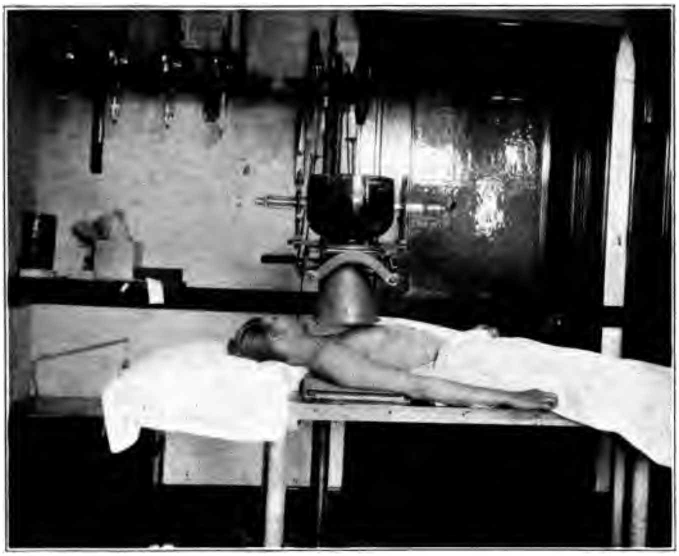

Fig. 25.—Anteroposterior shoulder position.

Part.—Neck

Size of Plate. 5x7. (2) 8x10. (1)

Diaphragm. Large and medium.

Position. A lateral view should first be taken. This is best done by having the patient sit in a chair with the tube tilted on its side (Fig. 26). Use the medium size Hickey cone, allowing it to rest on the patient's shoulder. In fact it should exert some pressure so that the shoulder is forced downward as far as possible. The plate (5x7) is held by an assistant against the opposite side of the neck, pressing it well down onto the shoulder, but at the same time not getting it too far from the neck. The patient is asked to sit in an attitude of dejection with shoulders drooped to their fullest extent. Unless this is done, the seventh cervical will not be reached. This plate shows the lateral view of all the cervicals.

In the anteroposterior position, the patient should be lying on the flat of the back, the head just off the table (see Fig. 27). An 8x10 plate is placed under the neck, extending up to the occipital protuberance. The rays are directed about 2 inches above the episternal notch. This will take in all the cervical vertebræ except the upper two or three.

The third position is to obtain these upper two or three bones from an anteroposterior view. The patient is on the back with the head resting on the table. The plate (5x7) is placed well up under the occiput. The mouth is opened to its fullest extent (about two inches), and a cork placed between the teeth. The small diaphragm is used, the rays being centered over the open mouth. This plate will show the first and second vertebræ very plainly.

Name of Plate.	Paragon or Seed's.	Cramer's.
Number of Exposures.	Three. Two anteroposterior; one lateral.	Three. Two anteroposterior, one lateral.
Spark Gap.	5½ inches.	4½ inches.
Milliamperage.	35 ma.	60 ma.
Distance.	18 inches.	22 inches.
Time.	Anteroposterior, 3 seconds; lateral, 2½ seconds.	Anteroposterior, 4 seconds; lateral, 3½ seconds.

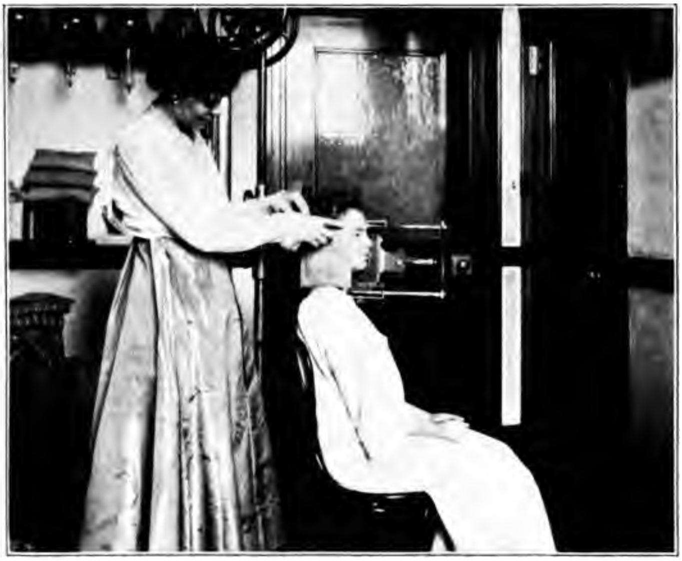

Fig. 26.—Lateral cervical spine position.

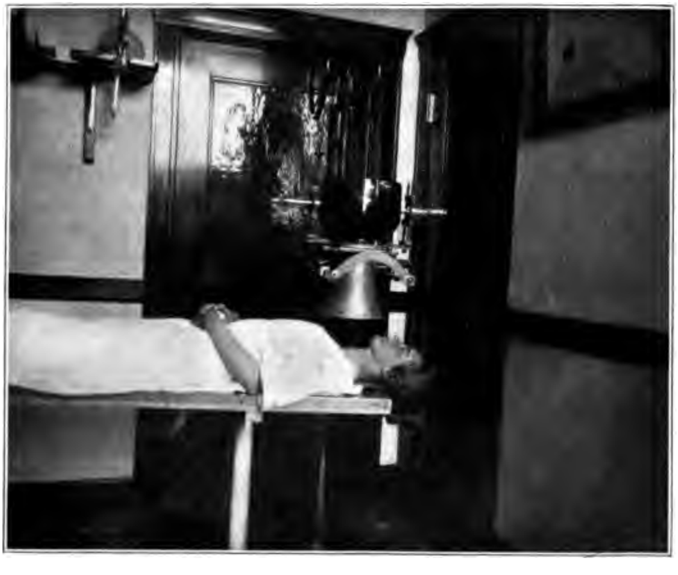

Fig. 27.—Anteroposterior cervical spine position.

Part.—Dorsal Spine

Size of Plate. 11x14. (3)

Diaphragm. Large.

Position. The upper end of the plate should be on a level with the seventh cervical running lengthwise down the spine with the body centered on it evenly from side to side. The principal rays should be directed over its center. This gives an anteroposterior view of the whole dorsal region (Fig. 28). For an oblique view, lay the patient on the face, rotating him a quarter turn upward one side or the other, placing the plate a little posterior from the center of the body (Fig. 29). Raise the arms strongly above the head. It relieves the strain somewhat to support the raised hip and shoulder by means of sand bags. If the true lateral posture is desired, the patient is laid squarely on the side with the arms extended well above the head. The plate is placed in position, remembering that the spine occupies a point about two-thirds back from the chest wall in front. In all these exposures it should be remembered that the patient should be directed to take a deep breath and maintain it during the time of exposure.

Name of Plate.	Paragon or Seed's.	Cramer's (with screen).
Number of Exposures.	Three.	Three.
Spark Gap.	5½ inches.	4½ inches.
Milliamperage.	35 ma.	60 ma.
Distance.	Anteroposterior, 36 inches; oblique and lateral, 30 inches.	Anteroposterior, 36 inches; oblique and lateral, 30 inches.
Time.	Anteroposterior, 10 seconds; oblique, 9 seconds; and lateral, 9 seconds.	Anteroposterior, 6 seconds; oblique, 5 seconds; lateral, 5 seconds.

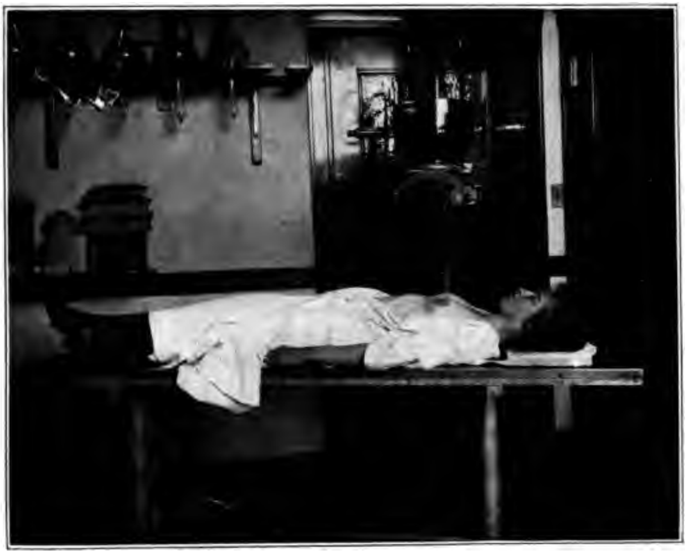

Fig. 28.--Anteroposterior dorsal spine position.

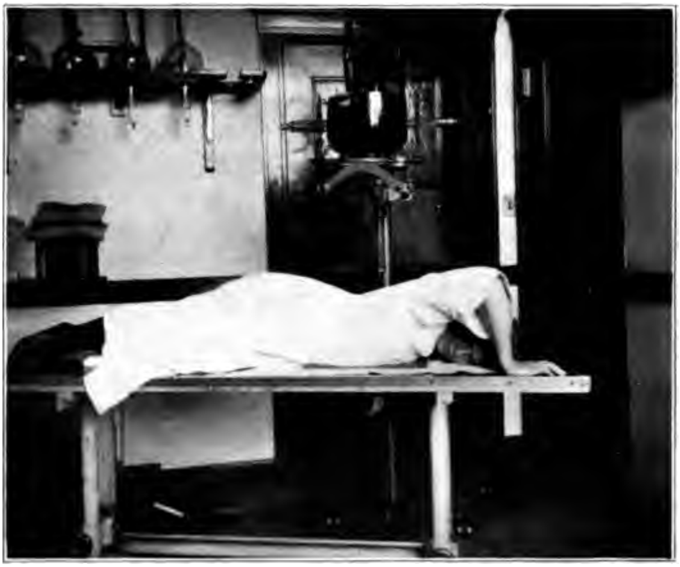

Fig. 29.—Oblique dorsal spine position.

Part.—Lumbar Spine

Size of Plate. 11x14. (2)

Diaphragm. Large with large size Hickey compression cone.

Position. Place the patient on the back with the plate well up to the mammillary line (Fig. 30). The cone is centered over the epigastrium having the upper edge just overlapping the costal arch. Compression is now made at the same time, tilting the tube so that the cone fits snugly into the epigastrium. The patient is instructed to take a full breath and hold it until the exposure is completed. The oblique view is made the same as in the dorsal spine, except that the plate and tube are moved downward so as to take in the lumbar vertebrae instead of the dorsal (Fig. 31). (See dorsal spine technic.)

Name of Plate.	Paragon or Seed's.	Cramer's.
Number of Exposures.	Two.	Two.
Spark Gap.	5½ inches.	4½ inches.
Milliamperage.	35 ma.	60 ma.
Distance.	Contact (about 18 inches).	22 inches.
Time.	5 seconds (without screen).	3 seconds (with screen).

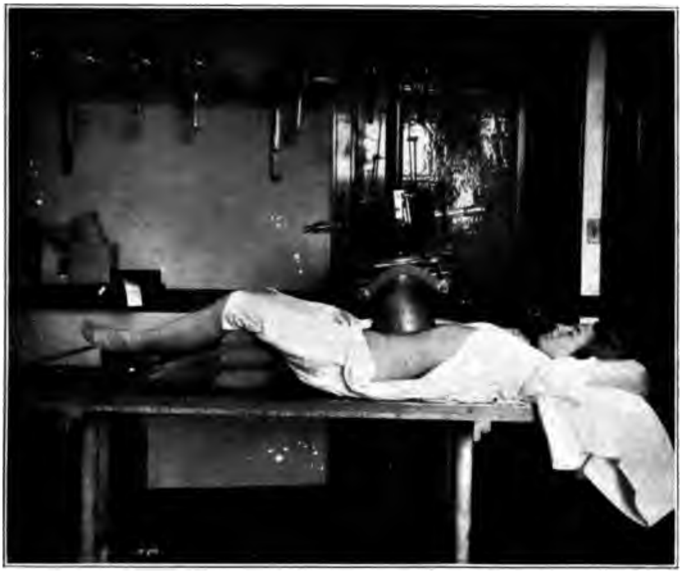

Fig. 30.—Anteroposterior lumbar spine position.

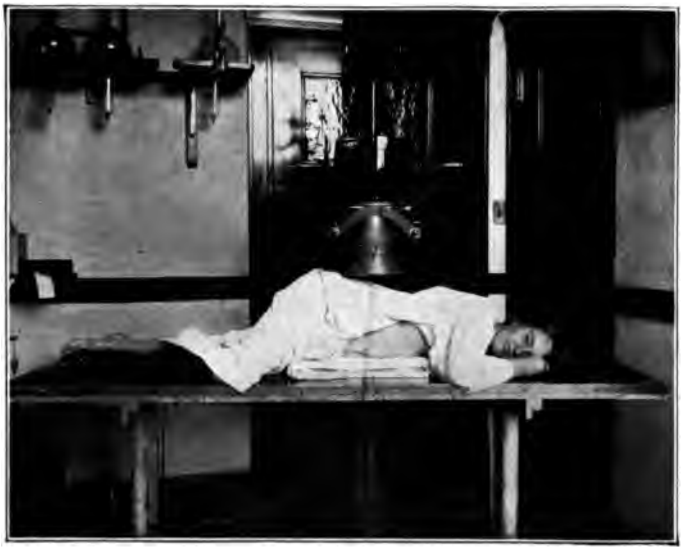

Fig. 31.—Oblique lumbar spine position.

Part.—Clavicle

Size of Plate. 8x10, if one is to be taken; 11x14, for both.

Diaphragm. Large.

Position. Place plate under clavicular region, having placed patient on chest (Fig. 32). The long way of the plate should run from side to side and should extend well out to the shoulder joint and high enough up so that the upper margin extends well up onto the neck. If one plate of both are to be taken, an 11x14 should be placed crosswise of the upper chest, the upper edge extending well up above the level of the clavicles. The tube should be centered over the spinous process of the second or third dorsal vertebra. The same instructions regarding the holding of the breath should be given as in the lumbar spine, for if there is any respiratory movement it will ruin the effect.

Name of Plate.	Paragon or Seed's.	Cramer's.
Number of Exposures.	One.	One.
Spark Gap.	5½ inches.	4½ inches.
Milliamperage.	60 ma.	60 ma.
Distance.	24 inches.	24 inches.
Time.	1 second.	2½ seconds.

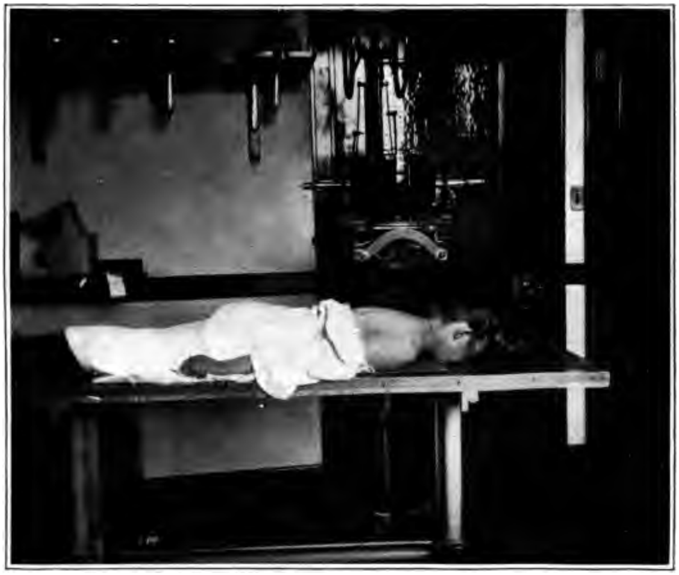

Fig. 32.—Clavicle position.

Part.—Scapula

Size of Plate. 10x12.

Diaphragm. Large.

Position. Place the patient the same as for taking the shoulder except the arm on the affected side should be raised above the head (Fig. 33). This throws the scapula toward the side of the chest. The plate is placed under the scapular region, the upper edge extending well above the shoulder lever, the inner edge extending to the spine. The tube is centered about two inches below the clavicle a little outside the mammillary line.

Name of Plate.	Paragon or Seed's.	Cramer's.
Number of Exposures.	One.	One.
Spark Gap.	5½ inches.	4½ inches.
Milliamperage.	80 ma.	60 ma.
Distance.	18 inches.	22 inches.
Time.	1 second.	2 seconds.

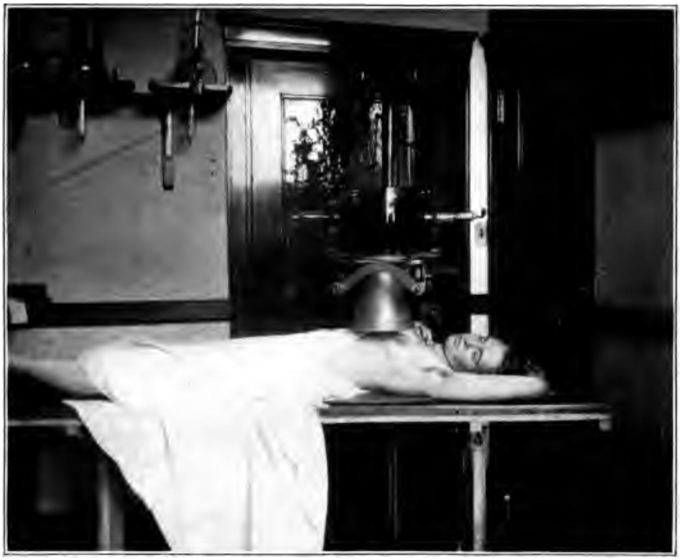

Fig. 33.—Scapula position.

Part.—Sternum

Size of Plate. 11x14.

Diaphragm. Large.

Position. This is the most difficult bone in the body to reproduce successfully. It is very rarely seen well done. The patient must be placed in the oblique position, that is, being laid on the face and then turned upward one-quarter turn. A deep inspiration must be taken and held. The plate is placed so that it will extend out anteriorly beyond the chest wall and well up on the neck. The tube is centered over its center. (Fig. 29.)

Name of Plate.	Paragon or Seed's.	Cramer's.
Number of Exposures.	One.	One.
Spark Gap.	5½ inches.	6½ inches.
Milliamperage.	60 ma.	80 ma.
Distance.	24 inches.	24 inches.
Time.	1¼ seconds.	1½ seconds.

Part.—Ribs

Size of Plate. 11x14.

Diaphragm. Large.

Position. Place the patient in the best position suited to bring the supposed fracture nearest the plate. This is usually oblique, either on the face or on the back whichever seems best. Center tube so principal rays will fall directly over painful area. Instruct patient to hold breath while making exposure. It is always advisable to place a lead marker over the suspected lesion (a lead letter stuck to the center of a piece of adhesive plaster placed over the area is good). This will identify the exact area on the finished plate.

Name of Plate.	Paragon or Seed's.	Cramer's.
Number of Exposures.	One.	One.
Spark Gap.	6 inches.	4½ inches.
Milliamperage.	60 ma.	60 ma.
Distance.	24 inches.	22 inches.
Time.	1 second.	2 seconds.

Part.—Urinary Tract

This examination is not complete until the entire tract has been taken, that is, both kidneys, both ureters, and the bladder.

It has been demonstrated many times that a stone in one kidney may give pain only in the bladder, and vice versa; also a stone in one kidney may give all symptoms seemingly in the opposite. It is therefore very incomplete to examine only one part with the possible lesion being situated in another.

Size of Plate. One, 11x14; one, 8x10.

Diaphragm. Large with large size Hickey cone.

A copious water enema should always precede this examination taken in the recumbent position; thus clearing the colon of all feces and gas.

Position. The 11x14 plate is used first, taking in both kidneys and both ureters close to their termination in the bladder. The patient is placed on the back, the shoulders and knees being raised and supported, and the plate being placed lengthwise, running from the eighth rib behind downward. (See Figs. 34 and 35.) The tube with large cone attached is now set down so that the upper edge of the cone just overlaps the costal arch. The tube is tilted a little so that the cone will conform a little better to the slant of the abdomen, and compression is made, bringing the spine close to the plate. The other plate takes in the lower ends of both ureters and the bladder. An 8x10 plate is used. This is so placed that the upper edge is about on a level with a line dropped from the navel. The lower edge of the large Hickey cone which is used is placed so that it just overlaps the pubic arch and the cone tilted slightly so that the rays are thrown slightly into the pelvis, that is, the upper edge is dropped slightly in the abdomen. (Fig. 35.) Compression is made, the knees having been lowered but the shoulders still being raised and supported. At the time of both these exposures, the breath should be held.

Name of Plate.	Paragon or Seed's.	Cramer's.
Number of Exposures.	Two.	Two.
Spark Gap.	5½ inches.	4½ inches.
Milliamperage.	35 ma.	60 ma.
Distance.	Contact, cone. About 22 inches.	Contact, cone. About 22 inches.
Time.	Kidney, 5 seconds (without screen). Bladder, 4 seconds (without screen).	Kidney, 3 seconds (with screen). Bladder, 2¾ seconds (with screen).

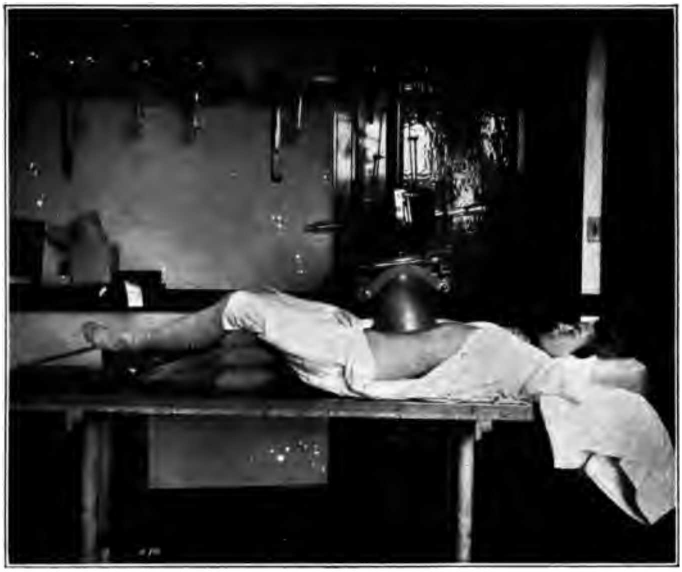

Fig. 34.—Kidney position.

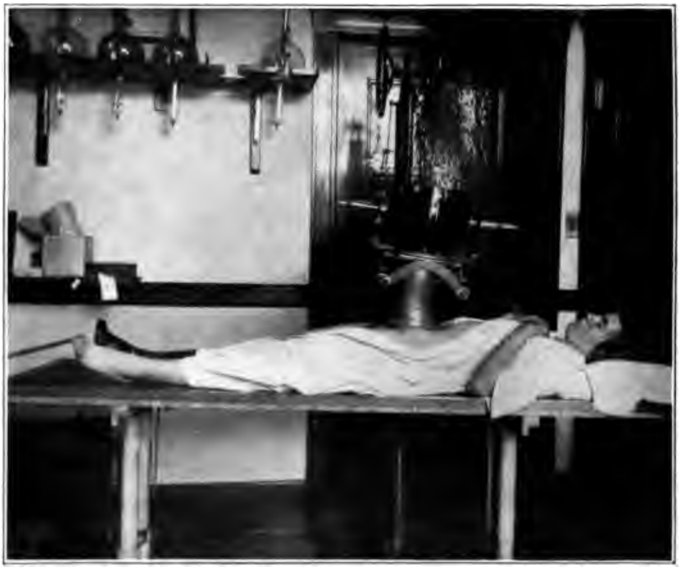

Fig. 35.—Bladder position on dorsum.

Pyloroentgenography

This is a branch of the roentgenological examination of the urinary tract that is used by some workers, very frequently. It consists in placing in the kidneys and ureters, a contrast substance so that they may be shown the same as the stomach is when filled with bismuth mixture. There are several methods employed:

1. Metal stylet enclosed in ureteral catheter.
2. Catheter impregnated with bismuth.
3. Specially prepared ureteral catheters, known as x-ray catheters.
4. Silver solution injection. (Collargol 10 per cent, Cargentos 20 per cent.)
5. Thorium solution injection, 15 per cent.

The patient is examined cystoscopically, using an instrument rigged for double catheterization. After both catheters are in their respective ureters, the protruding ends are attached to a graduated glass cylinder holding 150 c.c., and the solution is allowed to run in under a very low pressure, the container only being raised a short distance above the patient. Pressure such as may be applied by a syringe should never be used as danger of forcing the solution out into the kidney substance or even of rupturing the pelvis becomes very possible. Upon the first sign of distress being evidenced by the patient, the flow is immediately shut off and the catheters removed. The amount injected for both kidneys and ureters should never exceed 15 c.c. The plate having previously been placed in position, the tube is centered over its center which will be about the navel, and after instructing the patient to hold an inspiration, the exposure is made. This will, if properly performed, show the pelves and calices filled, as well as both ureters.

This reveals a very good idea of the size of both kidneys, their position, and the course and length of both ureters. One will be able to rule out, among other things, nephroptosis and ureteral kinks. If a stone is in the ureter, the solution will probably not pass it, but stop as soon as the obstacle is met, the ureter filling from there down. An opaque injection should never be done until a thorough examination of the entire tract has been made, ruling out calculi, which of course would be obscured by the opaque media used. If nephroptosis is suspected, it is advisable to take a plate not only in the prone position but also standing if the condition of the patient warrants it. It is sometimes desirable to demonstrate the presence or absence of vesical diverticula. This is best accomplished by filling the bladder by means of an ordinary rubber catheter attached to a glass cylinder containing a contrast solution, composed of either of the following mixtures:

Barium sulphate	3 oz.
Ol. amydalæ dulcis	15 oz.
Or	
Silver iodide	2%

Use about 16 oz.

All or as much as can be comfortably borne is injected, and then after turning the patient once on the face and back again to distribute the solution, the exposure is made.

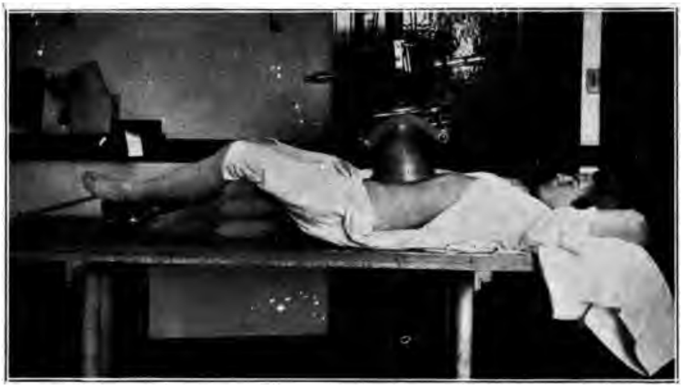

Fig. 36.—Kidney position.

Part.—Kidneys, Ureters, and Bladder. (Injected.)

Size of Plate. 14x17, 11x14, and 8x10.

Diaphragm. Large, with large Hickey cone.

Position. One plate should be taken with the patient on the back, the plate being placed so that it extends well under the ribs posteriorly. The 14x17 plate should be used without diaphragm or cone, the entire tract being obtained. Another plate (11x14) should now be placed so that its upper edge extends well under the posterior ribs and using the large size cone and diaphragm, the tube is tilted so that it fits into the anterior abdominal wall under the costal arch. (See urinary tract examination.) Two 8x10 plates are used in examining the injected bladder. With the first, the patient is placed on the back, the plate and tube being located the same as for the bladder examination. With the second, it is well to place the patient on the face, putting the plate so that its lower edge is below the pubic arch about two inches. The tube with large cone and diaphragm is tilted so that the principal rays strike about the anal opening. (See Figs. 36, 37 and 38.)

Name of Plate.	Paragon or Seed's.	Cramer's.
Number of Exposures.	Three.	Three.
Spark Gap.	5½ inches.	4½ inches.
Milliamperage.	35 ma.	60 ma.
Distance.	30 inches (14x17). Contact (11x14, and 8x10).	Same.
Time.	Kidney, 5 seconds (without screen). Bladder, 4 seconds (without screen). With 14x17 at 30 inches, 9 seconds.	Kidney, 3 seconds (with screen). Bladder, 2¾ seconds (with screen). With 14x17 at 30 inches, 5.8 seconds (with screen).

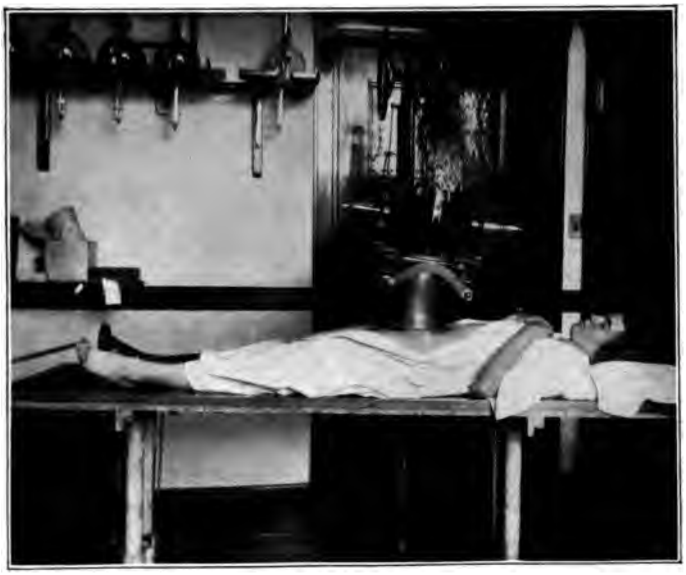

Fig. 37.—Bladder position on dorsum.

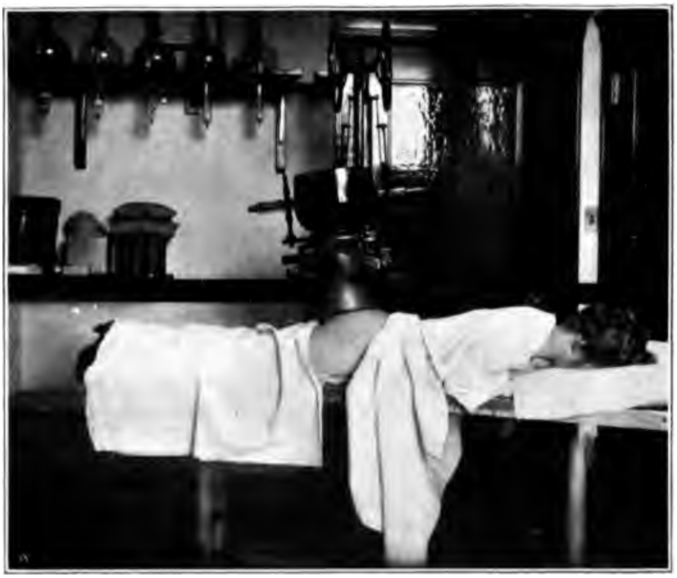

Fig. 38.—Prone bladder position.

Chest Examination

The clothing having been removed, the patient is taken into the fluoroscopic room and viewed through the vertical instrument. First, the two apices are observed by forming the diaphragm aperture into a horizontal slit about 2½ by 8 inches. The patient is asked to take several deep inspirations followed by a cough. By this means can be ascertained whether either apex fails to fill well or "light up" as it is commonly phrased. Following this the aperture is changed to a vertical slit somewhere about 3 by 10 inches. Both hila are now examined to note any thickening, or other abnormality. At this time the heart is gone over hurriedly, more particularly to ascertain the presence or absence of aortic aneurysm. The shape and size are also noted. Following this, both complementary spaces (the lung tissue extending down between the arch of the diaphragm and the ribs) are observed for cloudiness, the patient being instructed to breathe deeply several times so that the excursion of the diaphragm can be seen on both sides. The patient is now turned a quarter turn to the left. The heart is now seen at the operator's right and the spine to the left with the clear posterior mediastinum between. It should be noted whether this space is as clear as usual or whether it is encroached upon by glands or enlarged aorta. After this the diaphragm is opened to its fullest, the patient is brought to face the operator, and the chest as a whole is viewed, all the while the patient breathing deeply. If anything of interest is seen, such as areas of consolidation, cavity formation, etc., it is closed down upon and observed more in detail. This detail is at its best only partial, for plates are the only satisfactory method of registering pulmonary detail, the fluoroscope showing practically only movement and certain gross pathology.

The patient is now reversed with back to screen and practically the same routine is gone over with. The case is now ready for the roentgenogram.

In doing chest fluoroscopy it is well to have the tube particularly soft. There is no necessity for excessive penetration, the lung being of such a spongy character, and the wealth of detail thereby produced is an extensive help in differentiating the various types of pathology met with.

Part.—Chest

Size of Plate. 14x17.

Diaphragm. None.

Position. Patient lies on chest, face straight ahead, with forehead resting on table. The upper border of the plate should be well up under the chin. Hands and arms at side with palms up. A deep inspiration is taken and the exposure made. (Fig. 39.)

Name of Plate.	Paragon or Seed's.	Cramer's.
Number of Exposures.	One. Some workers prefer that the chest always be taken stereoscopically. This is a matter of preference.	One.
Spark Gap.	5½ inches.	5½ inches.
Milliamperage.	60 ma.	60 ma.
Distance.	30 inches.	24 inches.
Time.	1½ seconds.	1½ seconds.

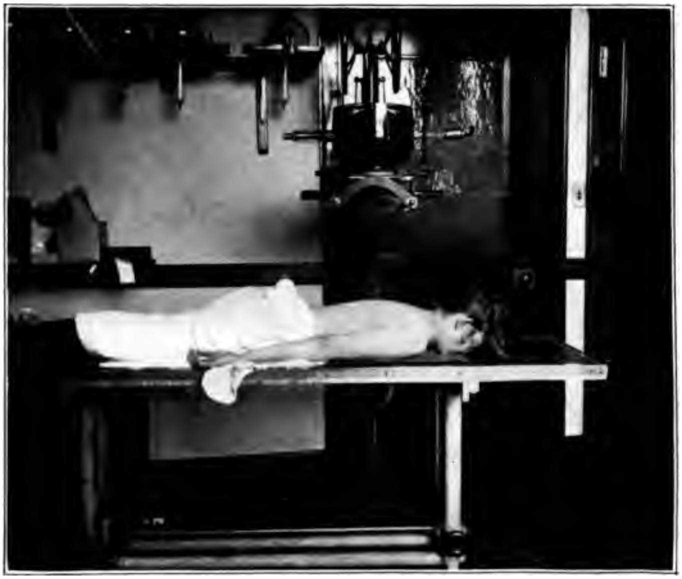

Fig. 39.—Chest position.

Part.—Head

Size of Plate. 8x10, or 10x12.

Diaphragm. Large.

Position. In looking for fractures of the base or vault, it will only be necessary to take stereoscopic plates with the head first on one side and then on the other, but if the sinuses are in question, to this must be added an anteroposterior and an inferoposterior. All hairpins and ornaments should be removed, allowing the hair to fall loosely. If looking for a suspected fracture, lay the head with the injured side down next the plate, resting it upon the stereoscopic box. The patient lies on the side with the arm next the table placed behind him. This brings the chest against the table and not only allows the head to remain nearer the table but insures a more steady position. (See Fig. 40.) A stereoscopic set is now taken as heretofore described, the long way of the plate being placed from before backward. When the accessory sinuses are desired, two plates are required. With the first the patient is placed face downward with the chin resting on an 8x10 running from above downward. The head is so placed that while the chin rests on the plate, the tip of the nose is about one-half inch distant from it. A large Hickey cone is used and is brought down so that it envelops the head, the principal rays being directed through the malar prominences. By assuming this position, the petrous portions of the temporals are thrown downward so that they do not obstruct the antra of Highmore. By using this position, one is enabled to compare as to density, both frontals, both antra, anterior and posterior ethmoids on both sides, and both mastoids to a limited degree; this, however, not being the best position for mastoids. Besides the sinuses this position shows not only the general conformation of the face but certain minor things like the nasal septum, and parts of the turbinates. The lower jaw, especially the anterior portion containing the central and lateral incisor teeth, comes out quite clearly. If now with one lateral view the sphenoid cells are seen to be clear, all has been done that is necessary; but if this area looks cloudy, an infero-superior view should be obtained.

For this the patient is placed on the back with the head hanging over the end of the table as far as possible (Fig. 41). A stool is now placed under the crown of the head with an 8x10 plate interposed. This plate should be parallel to a plane drawn through the external auditory meatus and the superciliary ridge. The tube with the small Hickey cone is placed so that the end of the cone comes under the chin, the principal rays striking the plate at right angles. This will show the butterfly-shaped sphenoid bone with the sphenoid cells in the center. Both sides can now be compared for any difference in their density. The anteroposterior head position is shown in Fig. 42.

If the case is one for general diagnosis of some indefinite head lesion, stereoscopic plates should be taken from both sides.

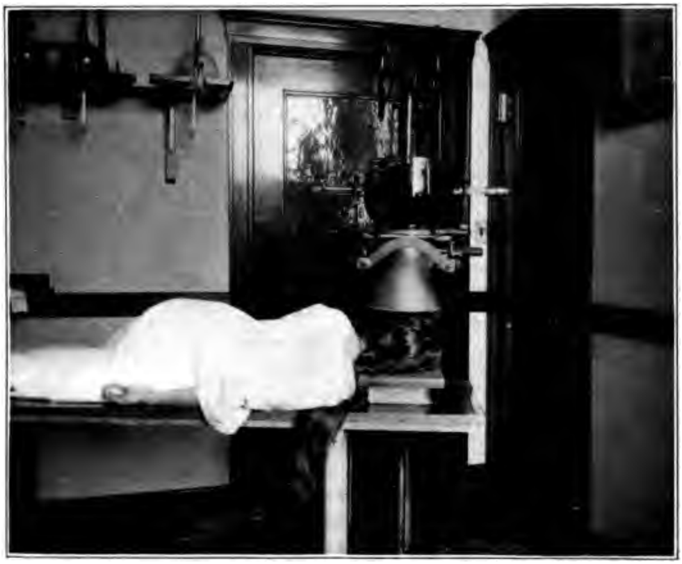

Fig. 40.—Lateral head position.

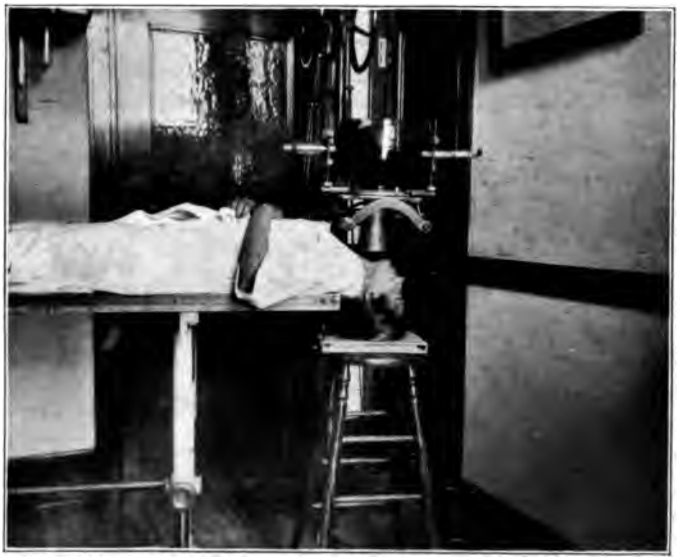

Fig. 41.—Inferosuperior head position.

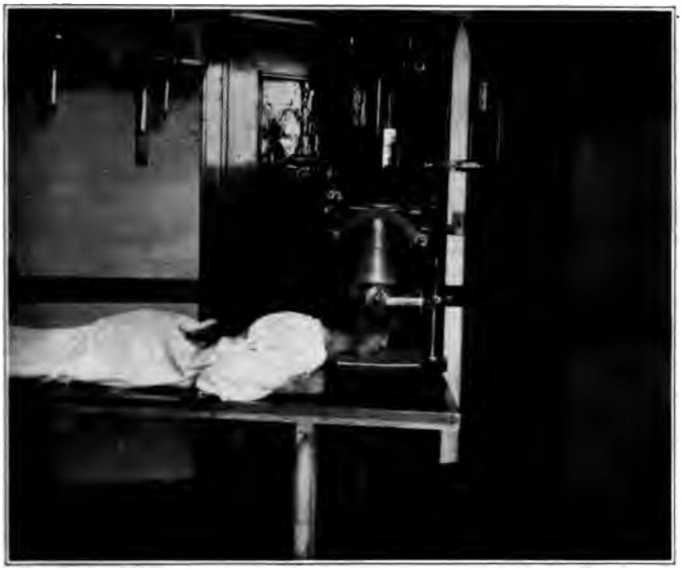

Fig. 42.—Anteroposterior head position.

In case the frontal bone itself is in question, it should be placed directly in contact with the envelope so as to bring out as much detail as possible.

The head is the only part of the body where a stereoscopic view must be taken from both sides, and it is only from the fact that the head is so thick that the side away from the plate is not distinct enough to make out the detail necessary. In a lateral stereoscopic view of the head, the half of the head nearest the plate shows up with great distinctness while the far side is very hazy. By reversing the process, both sides are brought out with the maximum of detail.

Name of Plate.	Paragon or Seed's only.
Number of Exposures.	Fracture of vault: Two, stereoscopical. Sinuses: Two, one lateral, one anteroposterior. (One, below upward, if necessary.) Indefinite pathology: Four, double stereoscopical.
Spark Gap.	6½ inches.
Milliamperage.	40 ma.
Distance.	Anteroposterior, 20 inches; lateral, 18 inches.
Time.	Anteroposterior, 5 seconds. lateral, 2 seconds.

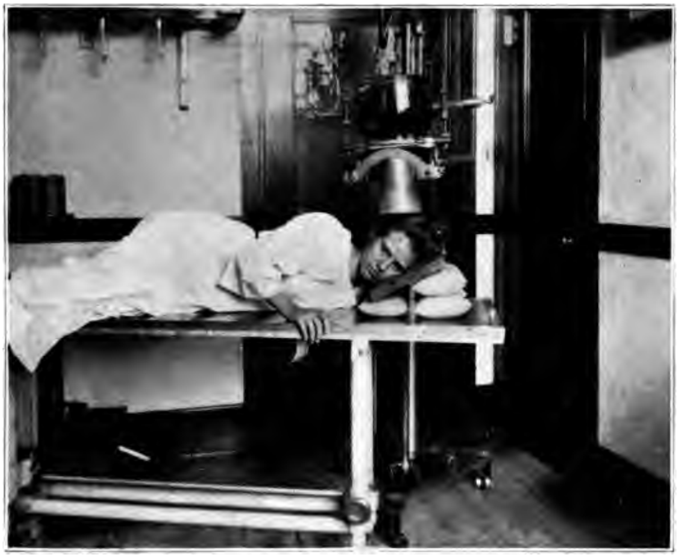

Fig. 43.—Mastoid position.

Part.—Mastoids

Size of Plate. 5x7.

Diaphragm. Small. Small Hickey cone.

Position. In mastoid work a plate should always be taken of both sides, so that they can be compared when finished. The patient is laid on one side with the arm next the table placed behind the body, the same as was suggested in the lateral head position. The head rests on a wedge, the base of which is raised from the table about 4 inches, the thin edge being placed under the neck and the thick side under the side of the head. This throws the head at an angle of about 30 degrees from the horizontal (Fig. 43). The plate is now placed with the mastoid in the center, the ear being turned forward so as not to overlap the cells. The tube is centered a little below and posterior to the parietal eminence so that the central rays will strike the process as it lays on the plate. This, of course, will cause the rays to strike the plate at an angle of about 60 degrees, but what distortion there is makes no difference as both sides are taken the same way and are thus in proportion.

Name of Plate.	Paragon or Seed's only.
Number of Exposures.	Two.
Spark Gap.	6½ inches.
Milliamperage.	40 ma.
Distance.	Cone almost in contact.
Time.	2¼ seconds.

Part.—Lower Jaw

Size of Plate. 5x7.

Diaphragm. Medium with a medium Hickey cone.

Position. The patient is placed in the same position as for a mastoid plate except the wedge is reversed, that is, the thick edge is placed under the neck, letting the head fall over it (Fig. 44). It is necessary that the neck be stretched to its fullest extent. This is imperative for by so doing the side of the jaw not wanted and farthest from the plate will be thrown out of range of the rays. The tube and cone are tilted so that the principal rays will strike directly on the jaw against the plate, being centered just in front of the larynx. This, of course, throws the rays at an angle to the plate of about 60 degrees which causes some distortion, but a satisfactory plate results.

Name of Plate.	Paragon or Seed's only.
Number of Exposures.	One.
Spark Gap.	4½ inches.
Milliamperage.	60 ma.
Distance.	About 22 inches.
Time.	3 to 4 seconds.

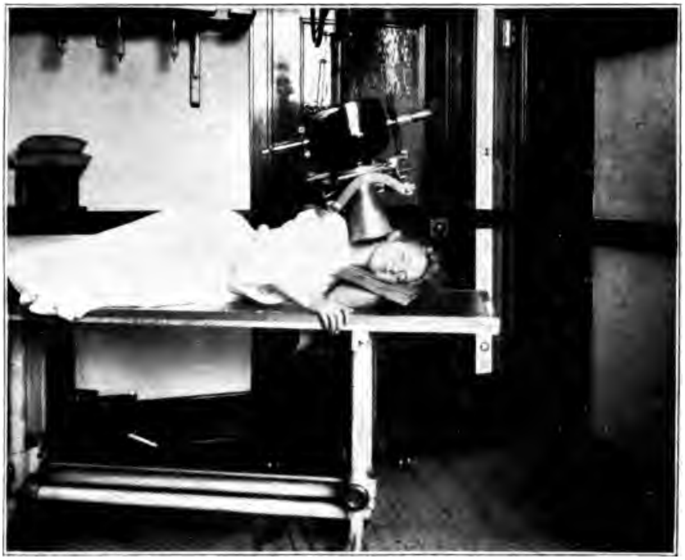

Fig. 44.—Mandible position.

Part.—Teeth

Size of Plate. Dental film 1¼x1⅝ (negative).

Diaphragm. Small with small Hickey cone.

Position. The film is placed inside the jaw opposite the tooth to be taken so that the tooth and alveolar process are interposed between it and the rays. The tube is now tilted so that the principal rays will strike the film at right angles. This is very important, for, if not done, the apices of the roots, the most important part, will not get on the film, the teeth appearing very long, extending all the way across the film. If the rays strike the film properly, the tooth will be seen normal in size. Always be sure that the film edge is about on a level with the chewing edge of the tooth, this will insure the apex on the film with sufficient bone tissue surrounding it to be satisfactory. The patient should be made to hold the films with the finger or thumb if possible. (See Figs. 45 and 46.)

Number of Exposures. Usually three teeth side by side can be taken on one film. It requires ten films to include all of the teeth.

Spark Gap. 4½ inches.

Milliamperage. 60 ma.

Distance. Almost cone contact.

Time. ¾ second for uppers; trifle less for lowers as the cone can be placed closer, usually about ½ second.

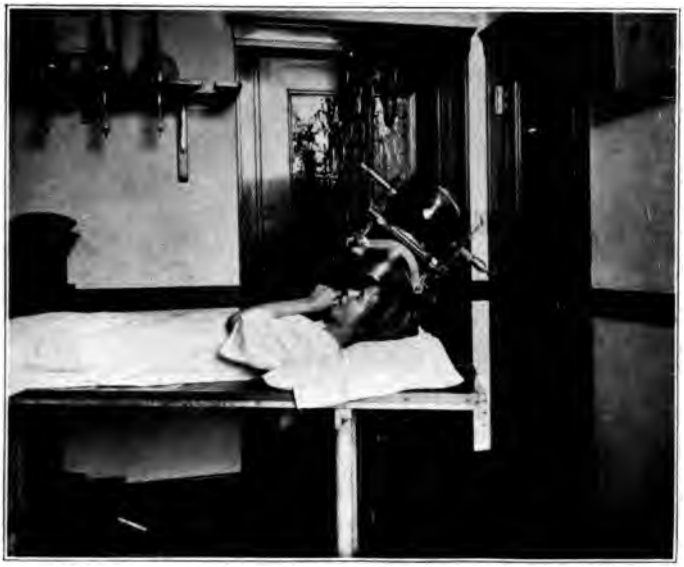

Fig. 45.—Position in taking upper teeth.

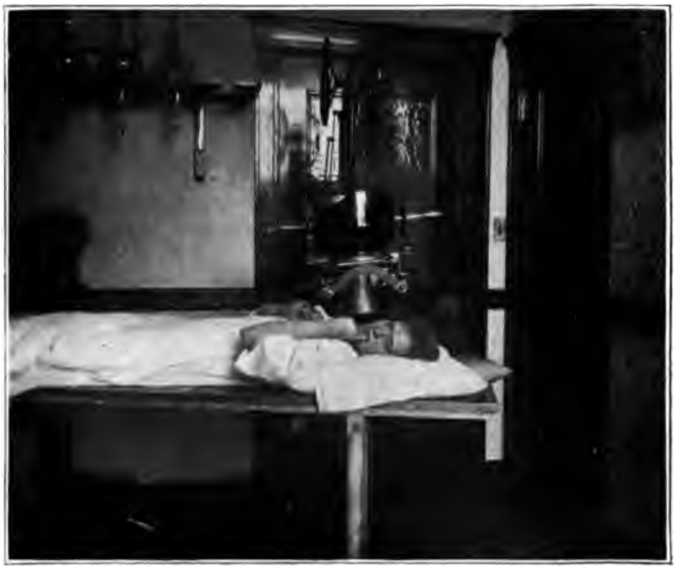

Fig. 46.—Position in taking lower teeth.

Part.—Gall Bladder

Size of Plate. 8x10.

Diaphragm. Medium with medium Hickey cone.

Position. The plate is so placed that its center is directly under a point on the right costal arch at the junction of the middle with the inner third. The patient is rotated a little to the right, bringing the right side close to the plate (Fig. 47). The cone is brought down so that its upper edge lies below the last rib at a point about equal distance from the spinous processes and the axillary line. The tube is tilted slightly upward and inward. The patient is instructed to take a deep inspiration and hold it during the exposure.

Name of Plate.	Paragon or Seed's.	Cramer's.
Number of Exposures.	4 to 6.	4 to 6.
Spark Gap.	5½ inches.	4½ inches.
Milliamperage.	35 ma.	60 ma.
Distance.	Almost cone contact.	Almost cone contact.
Time.	1¼ to 3 seconds (with screen). Average, 2 seconds.	2 seconds (with screen).

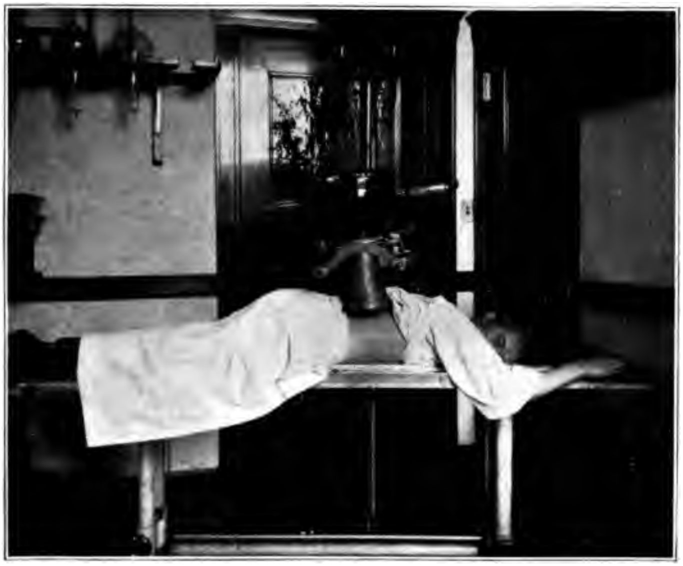

Fig. 47.—Gall bladder position.

Examination of the Esophagus

This examination is made to determine stenosis resulting from malignancy, chemical action (lye, phenol, etc.), spasm, pressure from the outside, possibly from enlarged or malignant mediastinal glands, aneurysm of aorta, and spinal disease.

Fluoroscope.—The patient is placed in the oblique position; viz., turned a quarter turn to the right, just enough to allow the posterior mediastinum to show clearly. In order to view the wall of the esophagus properly, it should be coated with a mixture somewhat more adhesive than the ordinary buttermilk mixture. Hirsch, of New York, in a recent communication recommended the following:

> A teaspoonful of mucilage of acacia is stirred up with a heaping tablespoonful of bismuth subcarbonate. Stirring should continue for ten minutes or until the mixture assumes a syrupy consistency.

A teaspoonful of this is sufficient to cover the entire tract and it remains long enough to view the tube with some deliberation. Peristaltic waves can be seen, external points of pressure can be noted and irregularities in the contour can be shown. Normally, the tract is clear in a few minutes, if, however, any lesion exists, the coating will remain considerably longer. After taking plenty of time to view the coated tract (giving more mixture if necessary), turning the patient a quarter turn not only to the right but also to the left and straight forward, one plate or a stereoscopic set is taken preferably with the patient standing in the right oblique position, although if necessary it can be done lying in the same position as for an oblique view of the stomach. (See gastrointestinal technic.)

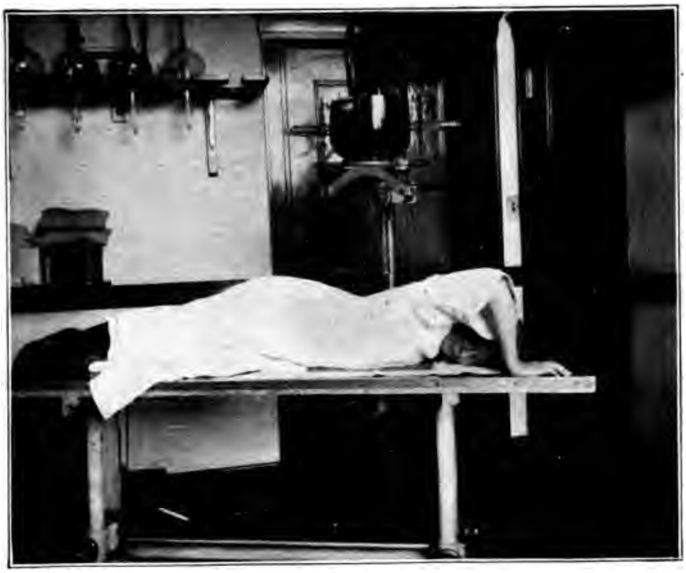

Fig. 48.—Position for esophagus.

Part.—Esophagus

Size of Plate. 11x14.

Diaphragm. Large with large Hickey cone.

Position. Oblique (quarter turn). Right breast to plate. Preferably standing, but not necessarily so. The patient is placed in the position to be assumed, and is directed to take a fresh swallow of the contrast mixture so as to be sure to have some in the tube at the time of exposure. The patient is told to hold the breath, and the exposure is made. (See Fig. 48.)

Name of Plate.	Paragon or Seed's.	Cramer's.
Milliamperage.	60 ma.	80 ma.
Spark Gap.	5½ inches.	5½ inches.
Distance.	24 inches.	30 inches.
Time.	1 second.	1½ seconds.

Gastrointestinal Examination

The patient, having fasted for at least eight hours, presents himself and is prepared the same as for a chest examination, that is, all the clothing is removed, and a kimono slipped on. (If a male, only the clothing to the waist line need be taken off, the pants being slipped down when the exposures are made.) He is now taken into the roentgenographic room where plates are made of the gall bladder. This is very essential as a routine in all gastrointestinal examinations trying to show gall stones, for it can not be done after the contrast meal has been given for fear of any stones that might be present being covered by the opaque media. (See gall bladder examination.) The opaque or contrast meal is now prepared. There are various mixtures used. Of the opaque ingredients bismuth subnitrate, bismuth subcarbonate, or bismuth oxychloride in 2 ounce doses, or barium sulphate 5 ounces are the most common. On account of the difficulty in obtaining chemically pure bismuth salts, barium sulphate is the safest preparation besides being considerably less expensive. It does not obstruct the rays quite as well as bismuth, but if given in large enough doses, is very satisfactory. Various vehicles in which to suspend the contrast substance have been used; namely, cream of wheat, farina, potato pap, mucilage of acacia, malted milk, gruel, corn meal mush, buttermilk, and various other things. Any one of them is satisfactory; but for routine office work, the buttermilk, either as obtained from the drug store soda fountain or prepared by one of the various buttermilk tablets on the market, is acceptable. Sixteen ounces are required. One meal should be adopted and maintained as a standard, for switching from one to another will lead to trouble, all of them giving varying results, such as filling of the stomach and duodenum, emptying time, etc.

Having prepared the meal, it is placed within easy reach, and a hurried examination is made of the chest, just to rule out any gross pathology that may have gone unnoticed. The patient is now placed in the oblique position the same as for viewing the posterior mediastinum, the container holding the contrast mixture is held in the patient's left hand and he is directed to take a few swallows. The meal is now viewed by the aid of the vertical aperture as it passes from the mouth to the cardia. This, in a rough way, determines whether there is any marked stenosis or spasm of the esophagus. After this has been determined, the stomach is viewed, noticing any irregularities such as notches, hourglass contractions or marked filling defects. The patient is now turned forward and the rest of the meal is directed to be taken. When the full amount has been ingested, the stomach is viewed as a whole, noting its shape, size and position. If peristalsis does not take place after a few moments, the patient is allowed to sit down for ten or fifteen minutes, after which waves will probably be noticed traveling from the cardia downward, especially on the greater curvature. The number, depth, and rapidity of these will be noted, as well as the pylorus and first part of the duodenum. A normal duodenum in its first part (cap) will be plainly visible as a sort of a triangular body with its base joining the pyloric sphincter which will be noticed as a narrowing. If there seems to be a sluggishness in the filling of the duodenal cap, a little pressure in the prepyloric region will, if normal, fill it out and will probably reveal the descending (second) portion, which is finally lost behind the antrum of the stomach as it approaches the ligament of Treit. The entire organ should be palpated to ascertain freedom of movement, filling defects or notches. When all data obtainable have been elicited, the patient is taken into the roentgenographic room and plates of the stomach made.

Part.—Stomach and Duodenal Cap

Size of Plate. 11x14.

Diaphragm. Large.

Position. From the fact that the cap, first portion of the duodenum, fills best in the prone position, from one to three plates are made with the patient lying on the face (Fig. 49). The plate (11x14) is placed under the belly lengthwise, estimating the position of the stomach from what has been seen with the fluoroscope. (It usually is from four to five inches higher when lying than when standing). After these have been taken, the patient is turned a quarter turn so that he is lying slightly on the right side, the plate having been slipped under previously. This not only brings the very important pylorus and cap near the plate but it shows the stomach in a different position. This is called the oblique position (Fig. 50) and by some is thought very important. The standing posture is now assumed (Fig. 51). The tube is tilted so that the rays pass parallel to the floor. The table is tilted to the vertical position supporting the plate, and the patient interposed. The stomach now, of course, will be in the same position as when viewed with the vertical fluoroscope, and the height of the plate will be determined accordingly. The patient must be instructed to stand very close to the table with the hands resting on the edge, else due to unsteadiness on the feet, movement will take place. Before each gastrointestinal exposure is made, the breath must be held.

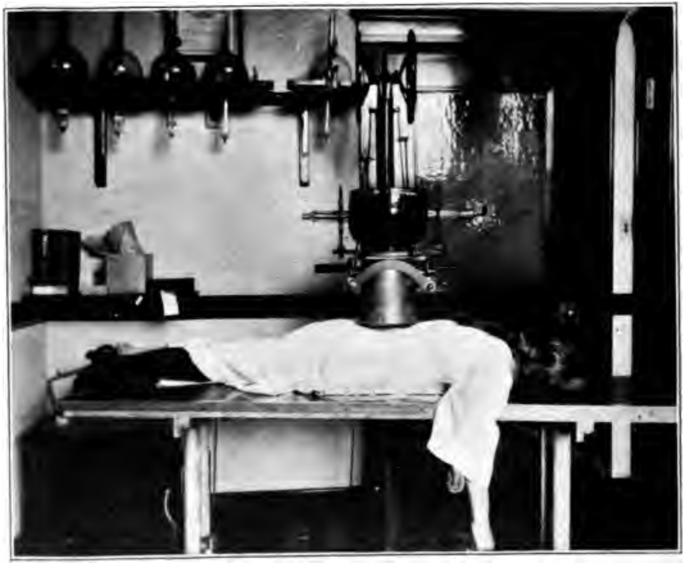

Fig. 49.—Prone stomach position.

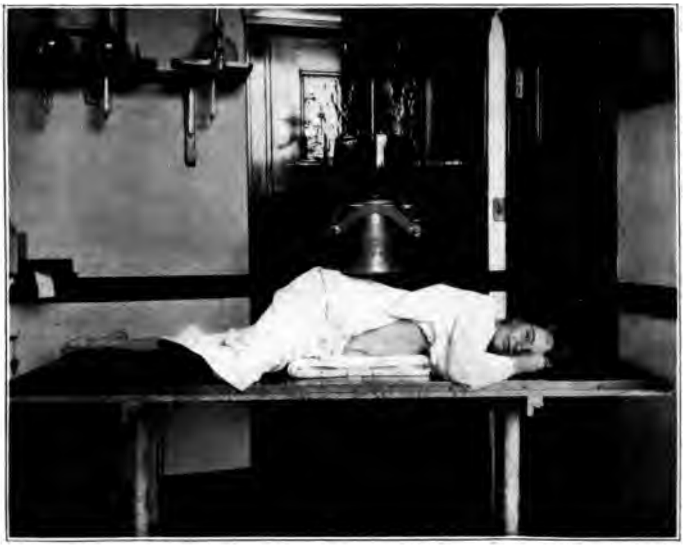

Fig. 50.—Oblique stomach position.

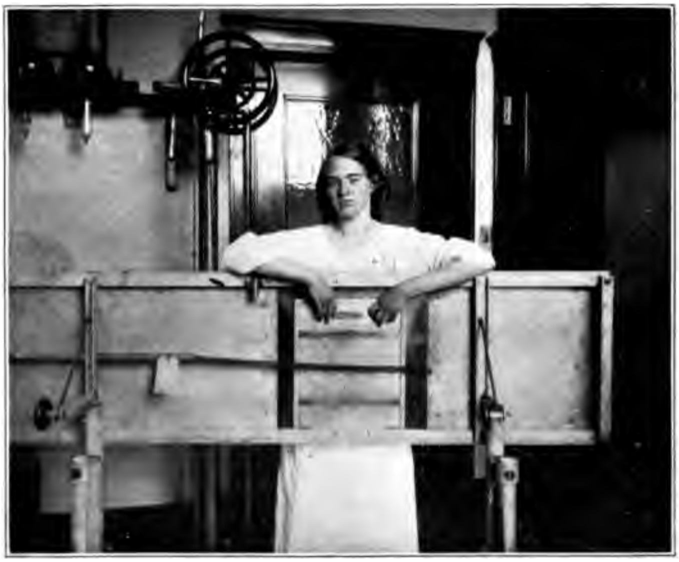

Fig. 51.—Standing stomach position.

Name of Plate.		Paragon or Seed's.	Cramer's.
Number of Exposures.		3 to 6.	3 to 6.
Spark Gap.—			
Size of Patient.—			
	Small	Prone, 6½ in. (without screen)	Prone, 6½ in. (with screen)
		Oblique, 6½ in. (without screen)	Oblique, 6½ in. (with screen)
		Standing, 6½ in. (without screen)	Standing, 6½ in. (with screen)
	Medium	Prone, 6½ in. (without screen)	Prone, 6½ in. (with screen)
		Oblique, 6½ in. (without screen)	Oblique, 6½ in. (with screen)
		Standing, 6½ in. (without screen)	Standing, 6½ in. (with screen)
	Large	Prone, 7 in. (without screen)	Prone, 7 in. (with screen)
		Oblique, 7 in. (without screen)	Oblique, 7 in. (with screen)
		Standing, 7 in. (without screen)	Standing, 7 in. (with screen)
Milliamperage.—			
	Small	Prone, 90 ma. (without screen)	Prone, 90 ma. (with screen)
		Oblique, 90 ma. (without screen)	Oblique, 90 ma. (with screen)
		Standing, 90 ma. (without screen)	Standing, 90 ma. (with screen)
	Medium	Prone, 100 ma. (without screen)	Prone, 100 ma. (with screen)
		Oblique, 100 ma. (without screen)	Oblique, 100 ma. (with screen)
		Standing, 100 ma. (without screen)	Standing, 100 ma. (with screen)
	Large	Prone, 120 ma. (without screen)	Prone, 120 ma. (with screen)
		Oblique, 120 ma. (without screen)	Oblique, 120 ma. (with screen)
		Standing, 120 ma. (without screen)	Standing, 120 ma. (with screen)
Distance.—		Lying and standing, 22 in.	Same
		Oblique, 24 in.	
Time.—			
	Small	Prone, ⅓ sec. (without screen)	Prone, ⅓ sec. (with screen)
		Oblique, ¾ sec. (without screen)	Oblique, ¾ sec. (with screen)
		Standing, ½ sec. (without screen)	Standing, ½ sec. (with screen)
	Medium	Prone, ½ sec. (without screen)	Prone, ½ sec. (with screen)
		Oblique, 1 sec. (without screen)	Oblique, 1 sec. (with screen)
		Standing, ¾ sec. (without screen)	Standing, ¾ sec. (with screen)
	Large	Prone, ¾ sec. (without screen)	Prone, ¾ sec. (with screen)
		Oblique, 1½ sec. (without screen)	Oblique, 1½ sec. (with screen)
		Standing, 1 sec. (without screen)	Standing, 1 sec. (with screen)

Serial Roentgenography

Very frequently it is advisable to have several views of the antrum of the stomach, the pyloric sphincter, and the duodenal cap, so that a complete cycle may be viewed. With this in mind, the author's colleague, Doctor A. F. Tyler, and the author designed and put in operation a table which accomplishes this in a very satisfactory manner. (See Figs. 52 and 53.) It is made to hold a 14x17 plate, obtaining sixteen views on same, which measure 3½ by 4¼ inches each. After the usual plates are taken, this apparatus is laid upon the roentgenographic table, the patient being placed on it face downward and

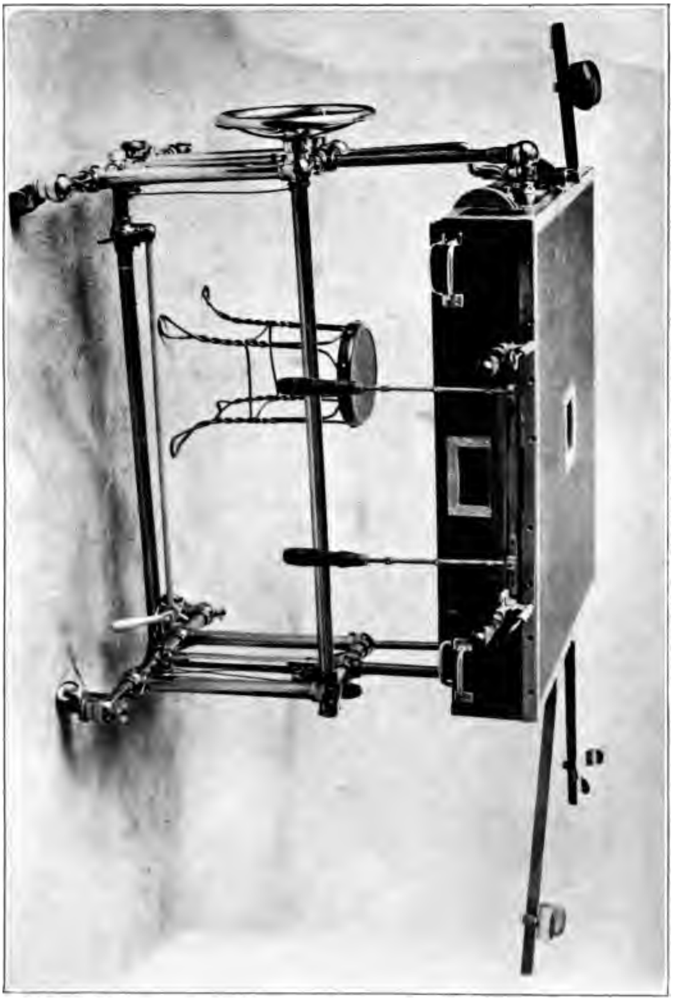

Fig. 52.—Showing serial plate apparatus ready for use.

put out by the Eastman Kodak Company, of Rochester, N. Y., this being a very reliable article. By using the *slow* variety, one has more latitude for error than with the *fast.* After lighting the lamps in the box behind the x-ray negative and opening the shutter in the camera, the camera is moved backward and forward until the size of the image on the ground glass at the back of camera is a little smaller than a slide (the ground glass should be marked with a square 3¼ by 4 inches, lantern slide size, in the exact center, also one 4 by 5 inches evenly outside this if this size is to be used). (Fig. 59.) Images must be taken always with the unexposed slide lying lengthwise as this is the only way they will fit in a lantern. After getting the focus, the camera is locked to the board by the thumb screw. The shutter is now closed and the plate holder with slide in place is inserted, the shutter opened and the exposure made. The time

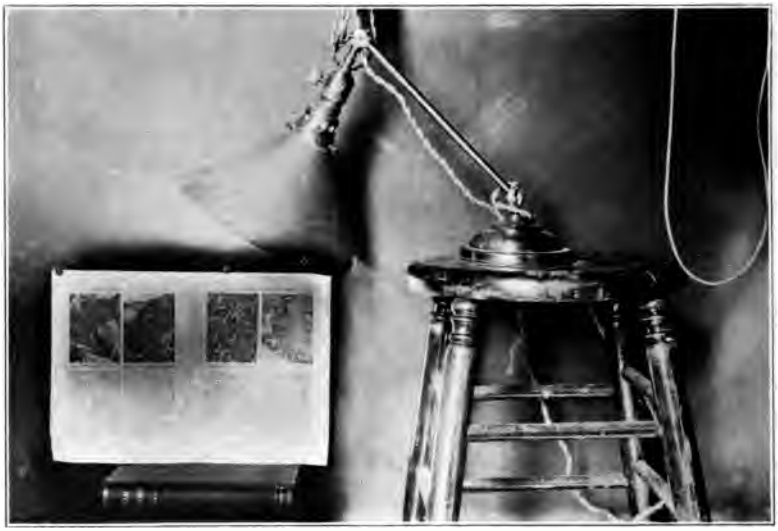

Fig. 60.—Simple method of arrangement for making lantern slides from illustrations.

well as from side to side, somewhat the same as a tube in a horizontal fluoroscope, there being a track running in both directions. The back and both ends are enclosed, leaving the front open. The top is lined with one-eighth inch lead having a square opening in the center 3½ by 4¼ inches. On the front edge of the top, there are two spring snaps opposite the two handles. When the plate holder is in position, it can be moved the required distance, 4¼ inches, and stopped. On the handles, which are circular steel rods, there are lugs every 3½ inches. The holder is started from one end, after having been pushed into the back of the box and moved four spaces, each 4¼ inches, it is then pulled out to the first lug, 3½ inches and returned in another four spaces or intervals. This is repeated until all sixteen spaces are covered.

In order to locate the sphincter over the center of the given space, the patient is first placed face downward on the horizontal fluoroscope, the duodenum and pylorus located, and a small cross with a skin pencil made, the intersection being over the sphincter. After this, the patient is laid face downward on the table; a steel rod bent to a right angle is set into a socket placed on the back side of the table which has an adjustable line hanging from its tip with a plumb bob on the end. It was determined in the placing of this socket and in figuring the length of the horizontal arm, that the plumb bob would fall squarely over the center of the opening so when the patient is in position and his body adjusted so that the plumb points squarely over the intersection of the cross, it is known that the pylorus too is squarely over the opening. The rod is now removed and the tube with the small diaphragm and cone are centered over the cross.

Following this the patient is directed to return at the end of six hours (fasting) so that the emptying time may be ascertained fluoroscopically. (Repeated examinations have shown that a normal stomach should be entirely empty at this time if given buttermilk mixture.) If the stomach is not empty at this time, the cause, if possible, should be learned, a plate being taken not only to record it, but to lend any possible aid in ascertaining the delay. The plate will also show how far the head of the meal has advanced, how much still remains in the ileum, etc. Twenty-four hours following the ingestion of the meal (18 hours following last observation) the patient presents himself again, having been given permission to take food, if desired, but no enema or laxative having been allowed. (If the stomach is not empty at six hours, it is desirable to observe the case every few hours if convenient until emptying has taken place and a note made of it.) At this time, the colon should normally be filled as viewed by the fluoroscope. It should be determined by palpation whether the colon is freely movable; whether any adhesions are present, either to surrounding parts or from one part of the gut to another; whether the appendix shows (it does at this time in about 75 per cent of cases) and if so, whether it is freely movable, bound down in the pelvis or, possibly up behind the cecum (retrocecal), whether it is tender to pressure; whether there is an elongated sigmoid loop, how much ptosis is present, if any, and whether the cecum or ascending colon are beginning to empty or not and anything further that may help in reaching a correct diagnosis. A plate is taken at this time, especially so if the appendix is visible. The case may from now on be followed by means of the fluoroscope only (unless something of interest presents itself which should be permanently recorded on a plate). The horizontal apparatus is used at any one of these observations if any further information can be obtained, as for instance, a transverse colon that sags down into the pelvis and can not be raised in the standing position, may come up readily if the patient is placed on the back. Adhesions at this point can sometimes only be demonstrated in this manner.

From now on the case is usually nothing more than determining whether a colon stasis exists, and if so, of how many hours. Most authorities give from 36 to 48 hours as the time the patient should be entirely free from the whole meal.

If the pathology is thought from the first to be located wholly in the intestines with the possible exception of an involved appendix, an opaque enema should be administered (the bowel having been previously emptied by a two quart water enema). Here it may be stated that in the author's opinion there is only one proper position to have a patient assume in taking an enema to fill the colon; that is, first, place him on the left side and insert the tube, having the container raised about three feet. The liquid is now allowed to flow into the bowel until about half of it is taken; he is now turned over so that he is lying flat on the face, and the remainder is given. If this method is carried out, there will usually be no griping and little desire to expel the fluid. He is now turned onto the back, the tube having been removed; and after the knees have been drawn up, the abdomen is lightly kneaded so as to insure a thorough distribution of the liquid.

The enema is prepared in various ways, two common and satisfactory methods being as follows: To one quart of heavy buttermilk add 5 ounces of one of the bismuth salts or 8 ounces of barium sulphate. This is placed in an ordinary irrigating can and warmed by placing the can in a sink or pail of hot water and agitating the contents, either with the hand or with a long-handled spoon. This also keeps the heavy powder from settling to the bottom and thereby clogging the outlet tube. The second and probably the better way is as follows: To 32 ounces of warm water add 7½ ounces of barium sulphate, and 15 ounces of kaolin. This after being well stirred is injected. Following the injection, the patient is viewed fluoroscopically. The same things are noted as seen subsequent to a meal from above with the exception that the appendix rarely shows when the contrast mixture is given from below. Ileocecal incontinence should also be looked for as this is the only method by which it may be demonstrated. It is sometimes advisable, especially if malignancy is suspected, to watch the enema injected by means of the horizontal instrument. This will reveal any point or points of hesitation, etc., which may be exceedingly helpful. The different parts of the gastrointestinal tract should never be examined separately, a meal should always accompany, and careful observations be made of it until it is wholly expelled.

Kuegle Technic

There has been an exposure table worked out by another of the author's colleagues, Doctor F. H. Kuegle, which probably puts exposures on a more exact basis than any other that has been observed by the author. With it, especially in bone work, a medium spark gap is used together with a small number of milliamperes and long exposures. In the author's opinion, the greatest disadvantage is the long time with its greater possibilities for movement. On the other hand, the great wealth of detail that can be secured if quiet is maintained is very pleasing. By this method all parts are measured, a certain time being allowed each centimeter. With the ordinary exposure table one is told to give a certain amount of time to a knee in an adult weighing approximately 160 pounds. It is well known that knees in 160 pound men vary, and the roentgenologist must use his own judgment; that is, a little less time must be given in the case of a tall, thin man, and a little more for a short stout man. By using the Kuegle method this personal element is done away with, there is a set time for each part.

The following is submitted as approximately correct in using both Paragon and Cramer plates:

All Bone Work

Centimeters in thickness	Time, in seconds	
	Paragon	Cramer
4	¾	1
5	1	1½
6	1¼	2¼
7	1½	3
8	2¼	4
9	3	5
10	4	6
11	5½	7½
12	7	8½
13	8	9½
14	9	11
15	10	12½
16	11	14
17	12	14½
18	13	16
19	14	17½
20	15	19
21	16	20½
22	17	22
23	18	23½
24	19	25
25	20	26
26	21	27

Milliamperes, 20.
Spark gap, 5¼ inches.
Distance, 24 inches.

Gastrointestinal Tract (Only)

	Time, in seconds	
	Paragon (Without screen)	Cramer (Screen)
Small (prone)	½	¼
Medium (prone)	⅞	⅓
Large (prone)	1⅛	½

Milliamperes, 65-70.
Spark gap, 6¼-6½ inches.
Distance, 24 inches.

CHEST (ONLY)

	Time, in seconds	
	Paragon (Without screen)	Cramer (Without screen)
Small	½	¾
Medium	¾	1
Large	1	1½

Milliamperes, 80.
Spark gap, 5¼-5½ inches.
Distance, 30 inches.

CHAPTER VI

SINUS INJECTION

Sometimes it is desirable to determine the course and origin of a sinus, usually leading from some focus in a bone, as possibly an old bone abscess with sequestrum formation, an old Pott's disease, or tuberculosis of the sacroiliac joint, a discharging pulmonary empyema, or even an unremoved bullet or other foreign substance. When this procedure seems necessary, the sinus is injected with Beck's bismuth paste which is put up by Parke, Davis & Company. It comes in collapsible tubes with a cap having a long snout. This is inserted in the sinus opening and held firmly by a wad of cotton about the opening. An assistant now makes pressure on the tube, injecting as much as the patient can stand comfortably or until it begins to come out around the cotton. A small piece of adhesive plaster with a lead marker in its center is now pasted over the opening not only to locate the opening on the plate but also to stop the bismuth from coming out during the rest of the procedure. Stereoscopic plates are now taken which, when placed in the stereoscope, will show the entire tract from one end to the other. Doctor Beck, in a recent article dealing with this subject, called attention to the importance of placing the bismuth injection container in a hot water bath before injecting so as to insure its easy accessibility into all recesses and cavities of the tract.

CHAPTER VII

LOCATION OF FOREIGN BODIES

There have been innumerable methods and devices recommended for the localization of foreign bodies, all of which in their place are good. Only two will be described here as they are perfectly adequate and require no additional apparatus. When one can take plates in two directions as in a forearm or ankle, it is hardly necessary to look further; stereoscopic plates are also very satisfactory, but to be a little more accurate, both of the following methods should be used, one to check the other.

Plate Method

It is well always to fluoroscope the part first to get some idea of the location of the foreign body; one is sometimes greatly surprised to find it many inches from its suspected location. This region is then placed over a plate of adequate size. The tube is set as for taking a stereoscopic set of plates, and the first exposure made. The tube is then moved as in the stereoscopic method (2½ inches) without tilting, however, and the plate remaining in the same position, another exposure is made as before. It will be seen on developing the plate that the object sought shows in two different positions, caused by the moving of the tube. It is now comparatively easy to figure geometrically the distance of the object from the plate. (See Fig. 54.) The distance from the anode to the plate is known, say 18 inches, and is represented by BC. The distance from DG is known, 2½ inches.

case is normal, it is put in in red ink (shown by shaded type in Fig. 65). In this way if it is necessary to obtain on short notice several normal plates, all one will have to do will be to look on the card of this particular subject and the numbers and names can be readily obtained. A list of the cards needed (which should be placed in the file alphabetically) is here given.

1. Accessory Sinuses.
2. Cardiovascular System.
3. Carpals.
4. Clavicle.
5. Femur.
6. Fibula.
7. Foreign Bodies.
8. Gastrointestinal Tract.
9. Head. (This takes in all conditions of the head with the exception of foreign bodies and accessory sinuses.)
10. Humerus.
11. Ilium.
12. Ischium.
13. Metacarpals.
13. Metatarsals.
15. Miscellaneous.
16. Os pubis.
17. Patella.
18. Phalanges (lower extremity).
19. Phalanges (upper extremity).
20. Radius.
21. Respiratory Tract.
22. Ribs.
23. Scapula.
24. Sternum.

The Fluoroscope Method

This method is practically the same as the preceding, using the fluoroscope instead of the plate. The horizontal apparatus is used. The distance from the anode to the surface of the table is known, say 18 inches. When the member in question has been placed on the table and the screen put in position, the distance from the table to the screen surface is obtained by means of a rule kept near by. This is added to the already known 18 inches which gives the total distance from the anode to the screen. The tube box is now moved so that the anode will be exactly under the object to be located, it having already been located and diaphragmed down upon. A mark should now be made with a blue pencil on the screen and also on the flesh (for further reference). The tube is now moved a known distance one way from the vertical, say 4 inches. This, of course, must be absolutely known, and can be determined by notches cut in the side of the table or by large brass headed tacks being driven about 2 inches apart. After the tube is thus moved it will be seen that the object is observed in a different location on the screen and this new spot is now marked. All that has to be done now is to measure between the two marks on the screen and the same problem presents itself as in the plate method.

CHAPTER VIII

DARK ROOM PROCEDURES

The main requisite of a dark room is absolute darkness. No ray of light, even the smallest, can enter without jeopardizing results. The room should be of goodly size, anywhere from 6 by 8 to 10 by 12 feet. A shelf should extend all the way around with the exception of the doorway and the sink or developing tank if there be one. The shelves may extend at varying distances all the way up to the ceiling, thus affording a great deal of storage space. On the side or sides which will be exposed to the x-rays there should be placed 1/16 inch lead sheets, extending from the floor up six feet. This is to protect unexposed and developing plates from becoming fogged. The main shelf running all the way around the room is placed about 32 inches from the floor. It should be about 18 inches deep. About 6 inches under this shelf there is placed another one the same width. On the developing side this is used to place the pans when not in use and on the loading side it is utilized for empty envelopes. Underneath this shelf on the loading side, a series of compartments is built (Fig. 55) for storing a daily or weekly supply of plates, and also space is left for the cassetted screens so that they may stand on end. Underneath the developing shelf, if tray developing is used, is a titubator or tray rocker. This is a very necessary article when this method is in use and should never be omitted. In using this method which, of course, necessitates a sink, a small overflow box should also be used; this not only allows fresh water for the hands (the water in the sink being more or less contaminated with hypo), but it prevents scratching plates that are already in the

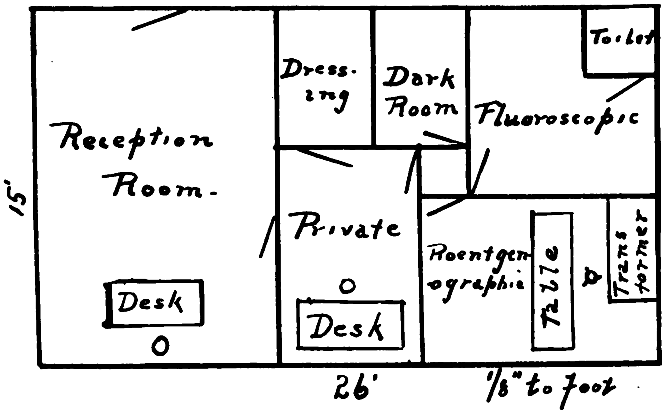

Fig. 69.—Floor plan No. 4.

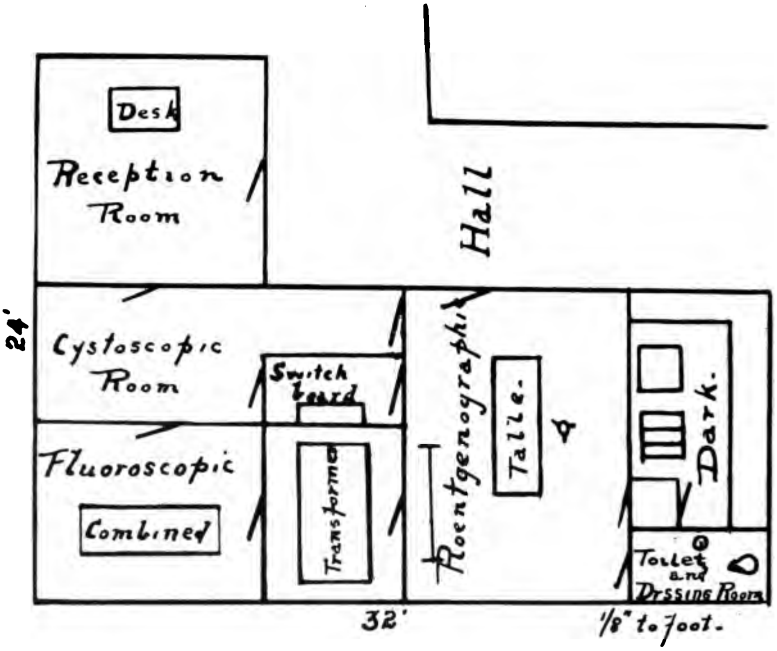

Fig. 70.—Floor plan No. 5.

opened and white light admitted. A dark room to be successful should be well ventilated not only for the satisfactory drying of the plates but also to be hygienic.

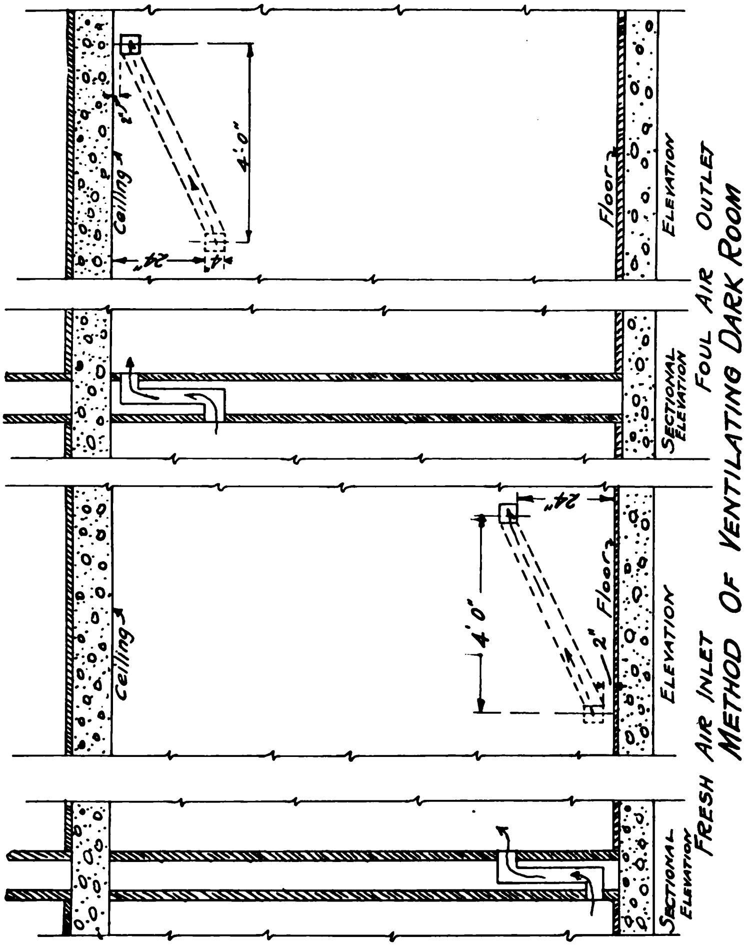

Fig. 56.—Ventilating shafts in dark room walls.

This is easily accomplished by having openings on two opposite sides of the room, one above the other so that a free circulation can take place. If the walls have been

the exposure was made, and thereby avoid embarrassment in sometimes not being able to state which side of the body has been taken.

Plate Protection

All plates not protected by the lead lined dark room should be placed in a metallic covered box, preferably lead. This is usually kept in or near the roentgenographic room so that in taking several plates, one will not have to run back and forth to the dark room between exposures, but can place the exposed plate in one end of the box, taking a fresh one from the other end. A plate not protected in some manner even at a great distance will be ruined if the tube is excited.

Development

Formulas for the development of different makes of plates are enclosed in each box, and it is advisable that one of several recommended be used for that particular plate, for it only stands to reason that the photographic chemists who make the emulsions are in a better position to know what developing agents should be used, and the amount, than another not so well acquainted with the facts. The following are some of the more common developers and are satisfactorily used with the average domestic plate.

All photographic chemicals should be weighed by the avoirdupois scale only.

DEVELOPERS

Solution 1.—

A.	Water	32 oz.
	Hydrochinone	1½ oz.
	Sodium sulphite	1 oz.
	Sulphuric acid	60 minims.

B.	Water	32 oz.
	Sodium carbonate	1 oz.
	Potassium carbonate	3 oz.
	Potassium bromide	120 gr.
	Sodium sulphite	3 oz.

Use equal parts of A and B.

Solution 2.—

A.	Water	1 gal.
	Metol	¼ oz.
	Hydrochinone	4 oz.
	Sodium sulphite	7½ oz.
B.	Water	1 gal.
	Sodium sulphite	7½ oz.
	Potassium carbonate	5 oz.
	Potassium bromide	¾ oz.

Use equal parts of A and B.

Solution 3.—

A.	Water	32 oz.
	Sodium sulphite	6 oz.
	Hydrochinone	1 oz.
	Edinol	5 dr.
	Potassium bromide	6 dr.
B.	Water	32 oz.
	Potassium carbonate	8 oz.

Use one ounce A, one ounce B, and two ounces water.

Solution 4.—

A.	Water	32 oz.
	Sodium sulphite	6 oz.
	Hydrochinone	1 oz.
	Edinol	4 dr.
	Potassium bromide	6 dr.

B.	Water	32 oz.
	Sodium carbonate	7 oz.

Use one ounce A, one ounce B, and two ounces water.

Solution 5.—

Water	20 oz.
Metol	20 gr.
Hydrochinone	80 gr.
Sodium carbonate	1 oz.
Sodium sulphite	1 oz.
Potassium bromide	10 gr.

Solution 6.—

A.	Hot water	40 oz.
	Sodium sulphite	7 oz.
	Potassium carbonate	14 oz.
	(Dissolve and add B.)	
B.	Adurol	2 oz.
	Metol	120 gr.
	Potassium bromide	120 gr.

Use one part solution to three parts water.

Fixing Bath

A.	Hyposulphite of soda (pea crystals)	4 lb.
	Water	120 oz.
B.	Water	70 oz.
	Chrome alum	4 oz.
	Sodium sulphite	8 oz.
C.	Water	10 oz.
	Strong sulphuric acid	½ oz.

After all solutions are well dissolved, pour C into B and this then into A. When solution CB is poured into A, the latter should be agitated. This will insure a clear solution free from sediment.

After the plate has been exposed and taken to the dark room and the envelopes removed, the patient's name and the date should be written in the upper right-hand corner (when using numbers with plate markers this will be unnecessary). The tray should be filled with solution at least ¼ inch deep and when putting the plate in, it is well to tip the tray away from one, slip the plate in and quickly tip the far side upward. This immediately causes an even flow of solution over the entire plate which is very essential for if one part is not covered as soon as the rest and remains so even for only a few seconds, it will be behind in the development and can never catch up. This will cause this part to be lighter than the rest of the plate. After the plate is entirely covered, it is necessary to rock it gently to and fro both lengthwise and sidewise until development is complete. This not only dissipates any air bubbles that may be in the solution and which obviously would retard development if allowed to remain standing in one place, but it also keeps the very small particles of undissolved chemicals from settling on the plate and thereby causing a more or less mottled effect on the film. If a titubator is used after the plate is once in the solution, the action of the rocker keeps the solution in motion. With tank development after removing the plate from the envelope it is placed in the holder and dropped in the solution where it remains quiet on edge until development is complete. It is very essential that the dark room and the developing solution be maintained at a given temperature, say between 65° and 70° F. A solution used when taken from a cold room will develop very slowly and show a minimum of density. This is due to the fact that the hydrochinone, which is a part of practically all solutions, acts very slowly at a temperature of 65°, and below that becomes almost inert. If, on the other hand, the solution is too warm, a plate with a muddy and foggy appearance will result. Where the solutions are kept in the dark room, which is the usual custom, all that is necessary is to keep the room temperature at the proper point and the solutions will be correct. In the hot weather a fan does very nicely and in the winter season a small electric stove properly protected so as to exclude all light and turned on when the temperature requires solves the problem adequately. A point may be mentioned here that is sometimes passed over lightly by some workers, but which is of the utmost importance, and that is, precaution should be exercised to keep hypo out of the developing solution. It does not seem reasonable or possible, but if even so small an amount as a few drops gets into a batch of developer it will be ruined. If skepticism exists, try it with two plates taken under like conditions before and after the addition is made. If one will make it a habit to dip the hands in running water after having them in any solution and drying them lightly, trouble will be avoided.

Different plates develop out differently. The three domestic plates used most commonly in the average laboratory are Paragon, Seed's and Cramer's. As the reader will probably use one or the other, no other makes will be taken up here.

Paragon Plate.—This is a very heavily coated plate holding an extra amount of silver in the emulsion. As it develops the image will be seen to *come up* and if viewed on the glass side, will be seen to be coming through, showing that the image is reaching through the entire thickness of the film. It will be noted when development has reached its height that the image on the film side is now beginning to fade somewhat, that is, becoming less distinct. If the plate is now held up to the red light, it will be found to be dense or black, no light from the ruby coming through. It is now ready for the hypo, but before placing it in the hypo, hold it